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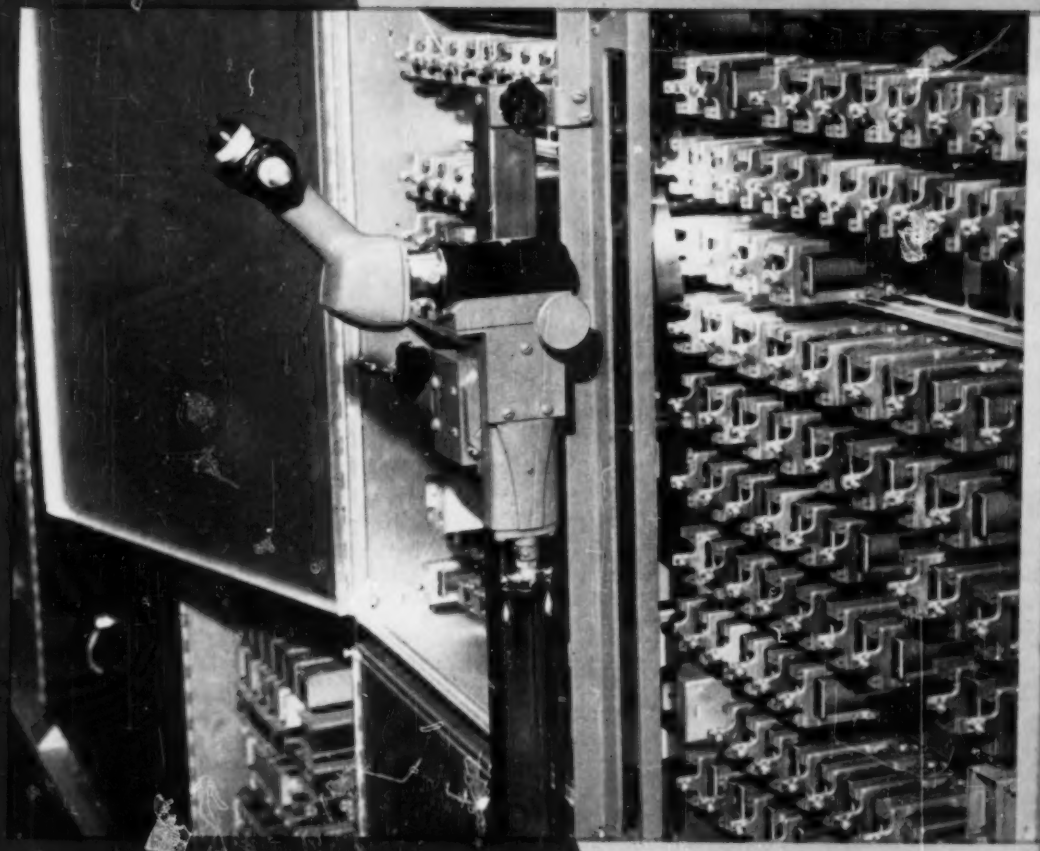
INDUSTRIAL QUALITY CONTROL



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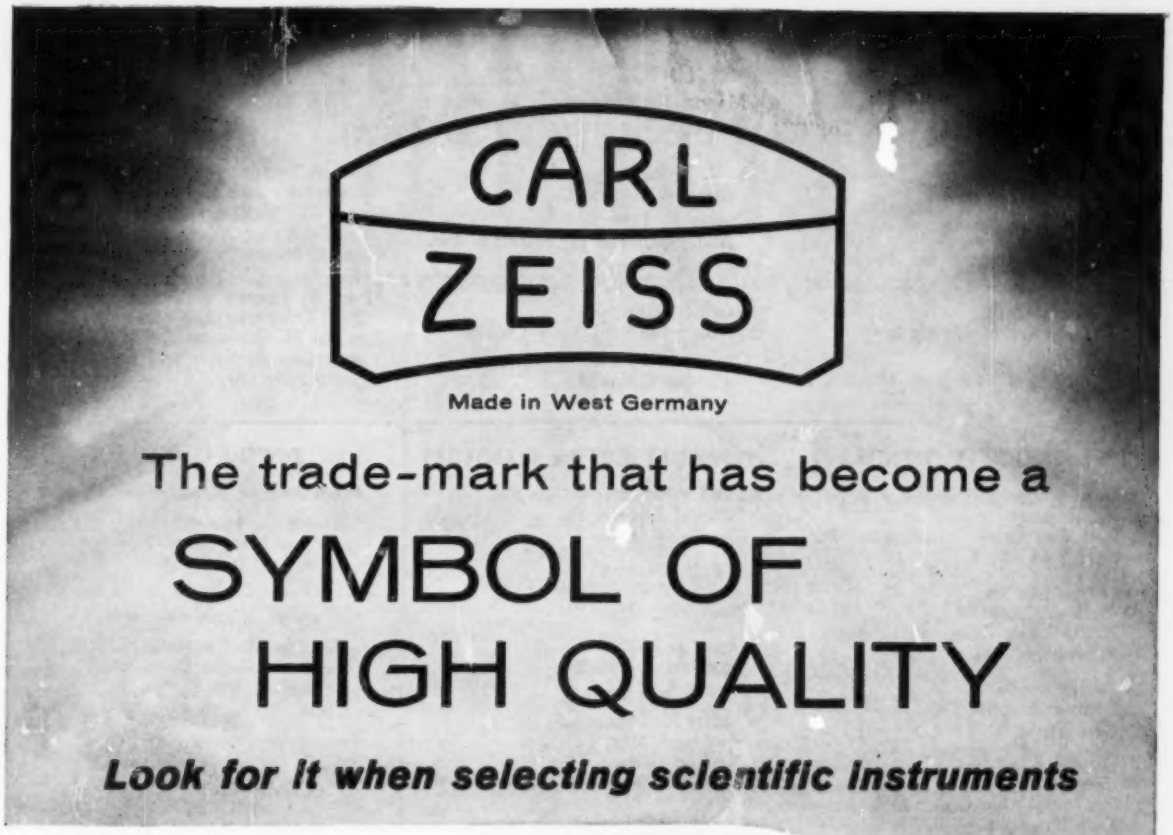

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Our Cover Picture

An optical measurement system designed to speed the sampling of contact erosion is shown in position in front of a bank of telephone relays. As it is mounted on channels above and below the bank, it may be readily moved along the track. The device is described by Ernest R. Lowrey in his article, "Optical Measurement Sampling of Relay Contact Erosion," on page 5.

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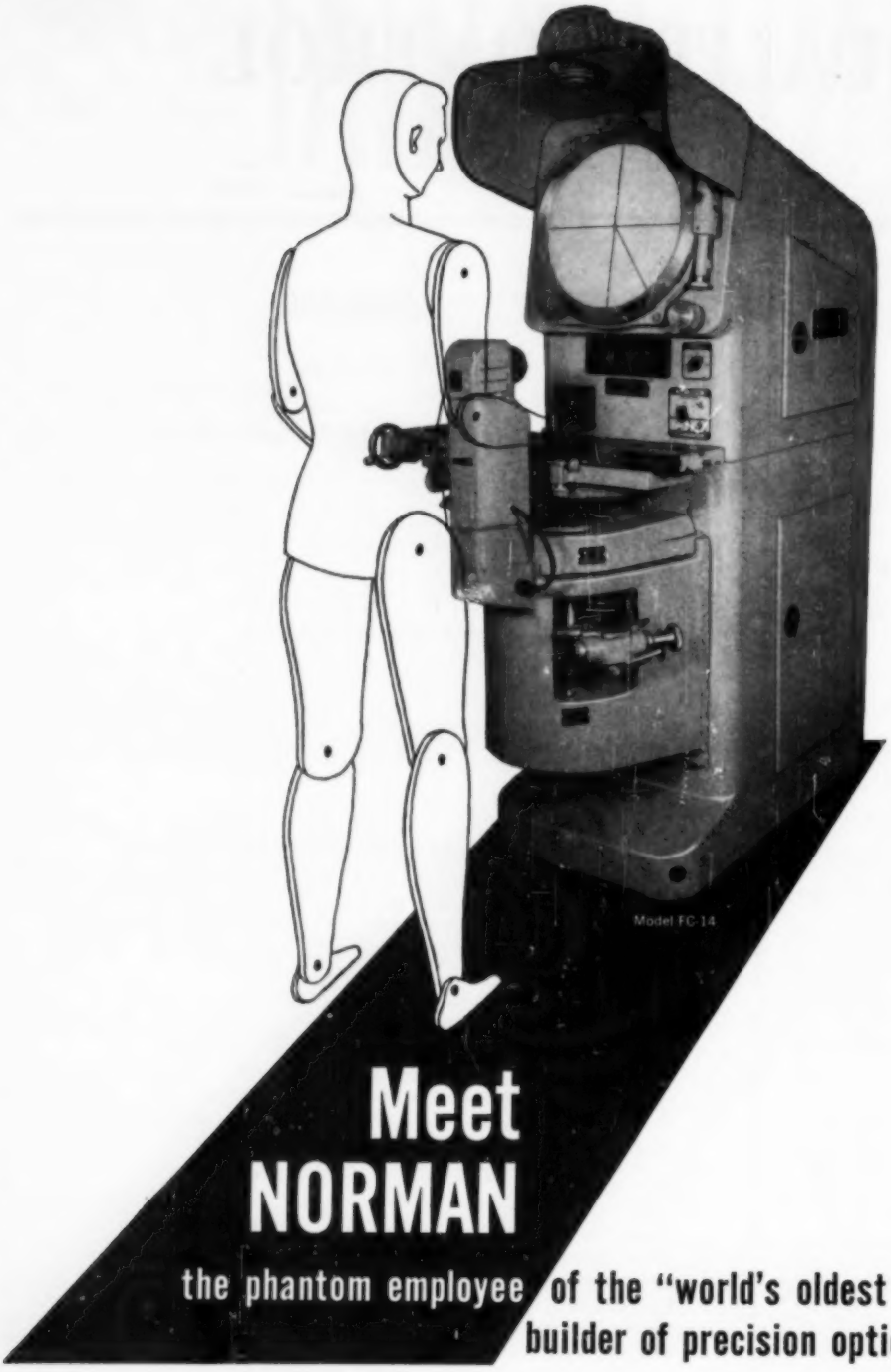

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Optical Measurement Sampling of

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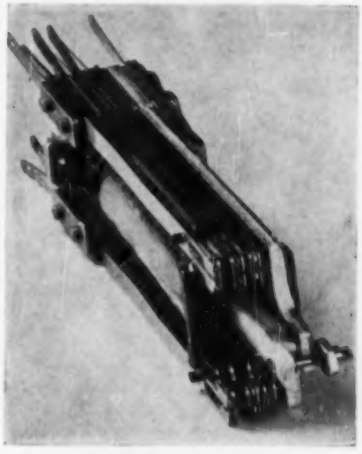

Figure 1—Typical Telephone Relay, Unmounted

ERNEST R. LOWREY

Illinois Bell Telephone Company, Chicago, Illinois

Introduction

This article describes the means used to solve a problem encountered in the maintenance of telephone central office equipment. It is limited to presentation of the situation existing at the time the facilities and techniques described were being put into use. The illustrative data therefore represent conditions which have developed over a long period during which the available controls were much less effective.

A large portion of the equipment in a modern dial telephone central office consists of relays. Depending on the number of customers served from the particular building, such an office will have from 50,000 to 400,000 relays, each with an average of five sets of contacts. The relays are components of functional equipment groups with varying operational requirements and rates of usage.

A typical telephone relay, as illustrated in Fig. 1, has contacts in the form of palladium or silver alloy bars about 0.045 × 0.085 × 0.017 inches thick. These are welded on the activating springs in twin sets, shown in Fig. 2 looking at the front of the equipment as mounted in place. The circuit function of relay contacts in many cases is to prepare

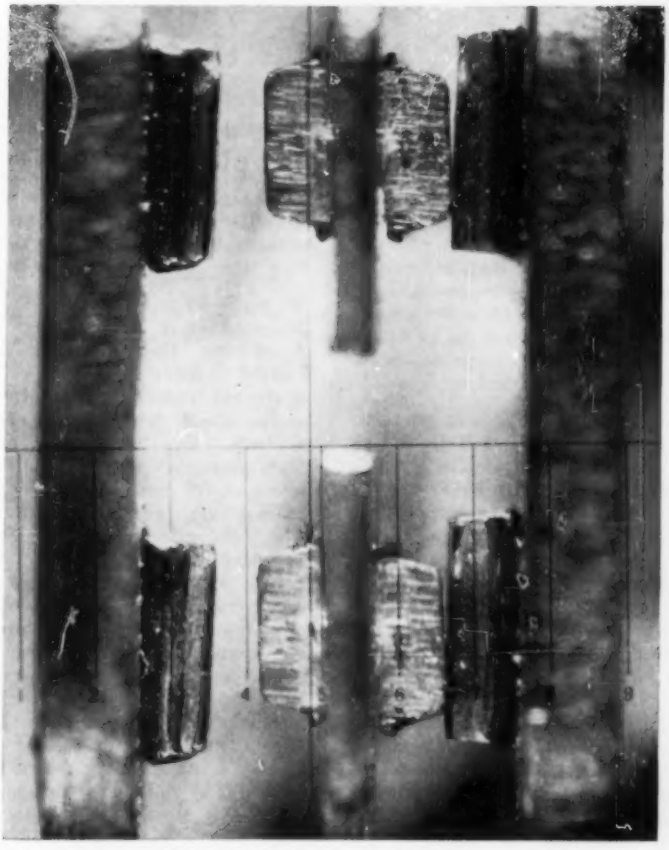

Figure 2—Enlarged View of Relay Contacts (1 Scale Division = 0.020 inches)

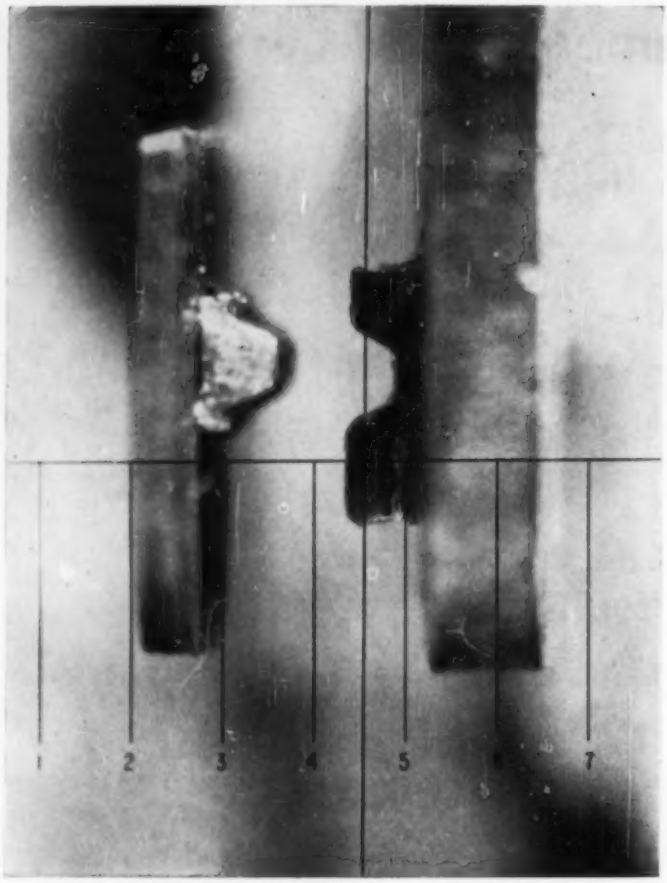

Figure 3—Eroded Contact, with Filar Micrometer Scale

for operations which are controlled by other elements. Such contacts are subject only to negligible wear from mechanical operation. Those contacts which do control the closure or opening of the current in a circuit are, however, subject to arcing and resultant electrical erosion.

For a particular design of relay the extent of erosion will depend on a number of factors. The current density and inductive energy of the load circuit are generally predictable for a given design application. The number of operations to which a relay is subjected varies with the call rate from office to office. The length of lead between a contact and its load also affects contact life, and this factor is often highly variable. Environment, length of time between operations, and certain mechanical adjustment conditions also have an effect on the erosion rate. Anticipation of all the interacting factors is a very complex problem from a design viewpoint.[1] The resulting variations in behavior also introduce difficulties in the maintenance of this equipment.

Under normal conditions, contact life up to 50 million operations can be expected of the relays now in general use. This can usually be increased considerably by provision of contact protection in the form of a capacitor in series with a resistor to drain away the excess current. Such protection is used where it is economically justified in terms of contact life, or in special cases where the effects of erosion would be particularly serious.[2] About half of the relays in a central office will have usage not to exceed 50,000 operations annually. Thus with normal contact loads, they can be expected to have many years' contact life. On the other hand, there are groups of relays required to operate 2 to 5 million times a year. Also there are some on which the usage runs to 25 million operations annually. It is with these groups of high usage equipment that our problem is primarily concerned.

Need for Statistical Quality Control Techniques

An electrical circuit failure due to erosion of a particular contact in the path has high probability of being an intermittent occurrence. The physical conformation of the erosion, variation in the actual minute points of contact, contamination of the contact surface with erosion products or foreign material, and the capabilities of the affected circuit elements in respect to time and current margins are factors in this situation.

Automatic checking features built into the circuitry serve to alert the maintenance force to the occurrence of trouble conditions in particular equipments. The complexity of the circuit functions make it necessary, however, that each such occurrence be investigated in detail by an expert maintenance man to determine the specific defect involved. In large equipment groups the particular circuit involved in an individual failure cannot always be identified or the fault may lie in any one of many circuit elements. Analysis of several failure indications is often necessary, therefore, to define the area in which the investigation should be centered.

As in any electrical or mechanical system, operational failures are to a large extent the result of aging, wear or environmental conditions. There is a high probability, therefore, that any one failure detected in telephone central office equipment is not unique. Considering this factor, together with the effort and time involved in correcting failures after they occur, it is necessary to have effective and economical means of anticipating situations where troubles are imminent. There is, of course, an inherent economy in performing specific reconditioning operations on a programmed "wholesale" basis, where mass production methods can be effectively employed. A logical maintenance program is, therefore, predicated on sampling suspected areas as a means of estimating the trouble potentialities. The success of such a program will depend to a great extent on the effectiveness of the sampling techniques in disclosing equipment conditions and their efficiency in diverting manpower from investigation to corrective activity.

Past practices have been lacking in both economy and effectiveness. Sampling plans have usually been specified on the basis of a considerable percentage of the lot. Means

for securing random selection have been left to the judgment of personnel not trained in the concepts of variability. The general use of go, no-go requirements for maintenance of equipment naturally leads to use of attributes in sampling, even though it would be possible to obtain variables data in some cases. To a great degree, however, the gages used in maintenance are not adaptable to measurement sampling.

Decisions on rehabilitation projects, perhaps particularly in respect to wear, are always complicated by a conflict of interests. On the one side there is the desire to minimize effort and to get full life from equipment parts and adjustments. There can be no true economy, however, in doing a full scale job by scattered bits and pieces. If only the extreme cases are cared for, additional service failure penalties and trouble clearing effort will be incurred as deterioration progresses. There is also a real hazard in interference and man-made troubles by repeated investigation and operations in the equipment. These risks can be minimized in an organized program.

These decisions involve the realization that deterioration exists, a picture of its extent, an estimate of its rate of development, and determination of the point for optimum balance between present and future penalties. A rehabilitation program caring for only those parts now at the failure point will obviously build in no margin for the future. Since attribute sampling gives no clue as to the distribution of parts now in the satisfactory range, such data are of limited value in setting up a program objective. Sampling by variables, on the other hand, will aid substantially in minimizing the difficulties of these decisions. The distribution of measurement values found in the sample allows statistical prediction regarding the condition of the entire lot with respect to the requirement limits. This distribution gives the administration a view as to the size of the job for rehabilitating the lot up to any desired measurement standard. Subsequent sampling after an interval will also provide an estimate of the deterioration rate with more precision than has been possible in the past.

Facilities for Measuring Contact Erosion

Measurement of wear or of linear dimension adjustments on telephone central office equipment would involve tremendous complications if attempted by mechanical gaging. Fortunately, a large proportion of the dimensions in which we are interested can be seen from the front of the equipment. An optical measuring system, therefore, makes a simple and almost universal tool for this purpose. An erecting, wide field microscope, 20× magnification, with eyepiece tube inclined 45 degrees has been found particularly good for this use. This has a field of 0.488 inches and a working distance of 3.5 inches. While measuring can be done with a graduated reticle eyepiece, there are advantages in a Filar Micrometer type (12.5×). This has a movable crosshair controlled by an indexed vernier dial. Dimensions are established by the difference between the vernier readings when the crosshair is set at the two ends of the dimension being checked. Very good illumination can be obtained with a small ring-type fluorescent light designed for use in close-up photography. There are undoubtedly several optical and illumination devices available which would be equally satisfactory. (The illustration on this issue's front cover shows these measuring facilities in use on telephone equipment.)

Relay contact erosion develops in the form of craters or notches on one or both members of a mating pair. Figure 3 illustrates a typical case, viewed with the Filar Micrometer scale and crosshair. Under some conditions of circuit load, there is a transfer of metal from one contact to its mate. The particular contact which receives the "build-up" is determined by the circuit polarity. There are thus three general conditions of erosion which may be encountered as shown in Fig. 4. (It will be seen that one contact of a pair is placed horizontally while its mate is vertical. This is to permit latitude in contact positioning.) Depending on the physical shape of the contact and location of the area, depth of erosion will not always be directly visible. However, from relations with the position of the mating contact the effective depth is determinable, and the measurements needed are illustrated in this figure. Note that the amount of contact metal remaining is the dimension of interest in this problem.

Sampling Plans

The problem of designing a sampling plan for maintenance rehabilitation is complicated by a number of factors. The objective is not a question of accepting or rejecting a lot of equipment. Rather, the decision is to be whether the equipment should be "reworked" and if so, to what extent. In effect, therefore, each case is to be presented to a "salvage board" for review. The lots to be sampled will not generally be of uniform size. In starting a sampling plan from scratch, the variation in the characteristic under study would likely be unknown. Current serviceability of the equipment will be indicated by the proportion of the distribution of the lot measurements lying below the minimum value for satisfactory operation. The economic decisions involve essentially an evaluation of the proportions of the lot at various increments above this critical value. These factors provide part of the data needed for estimating the optimum frequency of rehabilitation.

Taking all of these considerations to account has led to the Lot Plot Method[3] as the logical choice of sampling plans. The sample meas-

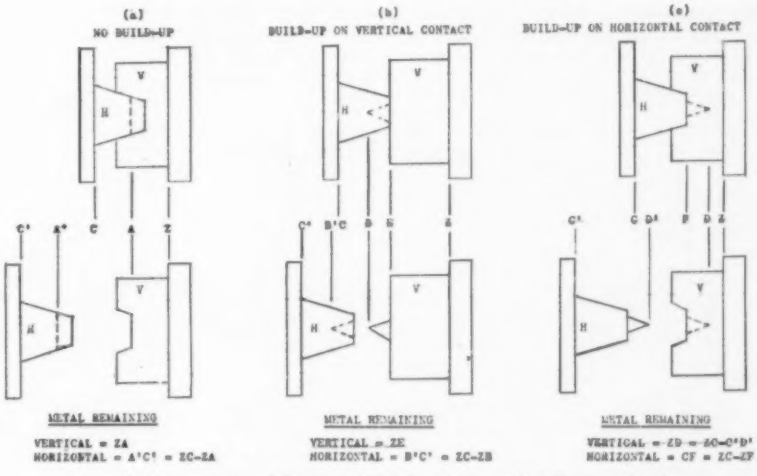

Figure 4—Measurement of Contact Metal Remaining, with 3 Types of Erosion

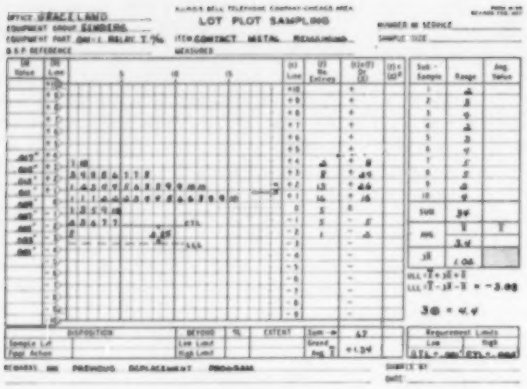

Figure 5—Moderate Wear Rate (Approximately Normal Distribution)

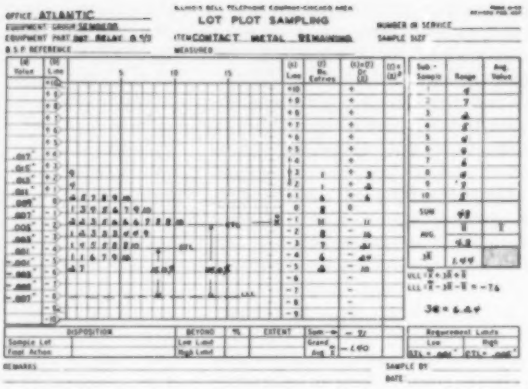

Figure 6—Extensive Wear (Approximately Normal Distribution)

urement entries made on the Lot Plot form constitute a visible frequency histogram. The calculations required to estimate the total lot picture from the sample results are quite simple. It is possible to estimate the proportion of items in the lot which lie beyond any desired measurement value. The method includes means for treatment of cases where the distribution is non-symmetrical. As discussed later, this situation may be encountered quite often in maintenance sampling. The suggested sample size of 50 items is economically attractive in most telephone equipment applications. As will be developed, however, there appears to be the possibility of reducing the sample size to 25 for the particular purposes covered in this article.

The sample items, taken at random from the lot, are divided into subgroups of five each. The scale of the frequency distribution is chosen so that it will contain 7-16 class intervals. The first subsample of five cases is distributed among the various class intervals, and each item is identified by an entry of "1" on the frequency chart. Similarly the second subsample items are identified by a "2" and so on. Thus while building up a picture of the entire distribution, $\bar{X}$ and R values for each subgroup are readily determinable. This has an important advantage in some situations encountered in telephone maintenance. Also, since all calculations are made in terms of class interval units, computations are much simpler than would be the case if the measurement values were used.

Guide Limits for Wear Tolerance

Speaking in the sense of this article where contact metal remaining is the characteristic being measured, the upper limit of the lot distribution is not of prime interest. In this case, there is a cutoff point determined by the contact design and manufacturing tolerances at approximately 0.017 inches. We are much concerned with the lower distribution limit and theoretically the minimum value of metal remaining would be 0.000 inches. However, particularly where there is a "build-up", erosion of the mating contact may extend into the base metal spring. In such cases the measurement of contact metal remaining is a "minus" value. The distribution may therefore be expected to lie between +0.017 and, say, −0.009 inches. With the lens combination used to measure these values, the Filar microscope vernier reads in 0.0002 inch increments.

From a service viewpoint, there should be no need to replace a contact as long as it is not worn through to the base metal spring. However, minute irregularities in the mating surfaces make it difficult to define this end point exactly. It has been considered sufficiently precise for our purpose, therefore, to consider any measurement of 0.001 inches or less contact metal remaining as being at the failure point. Also, if the sample distribution indicates a high probability of any contacts in the lot being 0.001 inches or less, this would be considered evidence of need for immediate action. The decision for this action would then be made if the Lower Lot Limit as estimated by the Lot Plot method falls at or below the top of the class interval representing 0.001 inches maximum.

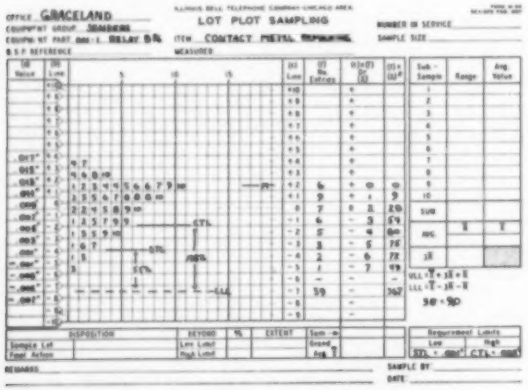

Figure 7—Moderately Advanced Wear (Skewed Distribution)

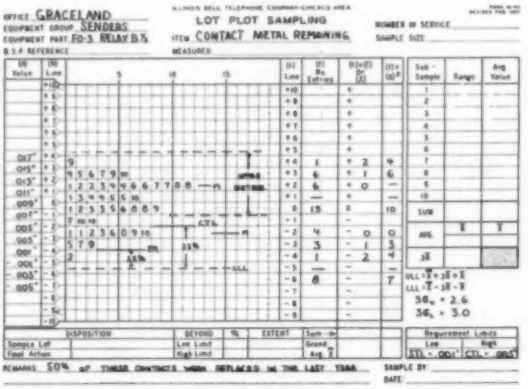

Figure 8—Rapid Wear Rate (Multi-Modal Distribution)

However, there is another consideration which must be taken into account in the event the Lower Lot Limit lies *above* this Service Tolerance. The matter involves the difficulty of pinpointing service irregularities resulting from contact erosion, the troubles which accompany too frequent operations in the equipment and the general economies of a balanced rehabilitation program. This consideration might be called a "Conditional Tolerance Limit," which would be a value somewhat higher than the "Service Tolerance." However, at the inception of this program there were no statistical data available on the rate of contact wear and the variation to be expected. Lacking means of determining the Conditional Tolerance point statistically, a tentative value of 0.005 inches has been established from empirical considerations.

If the Lot Limit estimated from a sample lies above the "Conditional Tolerance," then no rehabilitation would be programmed as a result of that sample. But, in case the Lot Limit falls between these two values, management can anticipate the approach of the failure point. Based on knowledge of the service effects from failure of the particular contact, and other factors of the job involved, a rehabilitation program can be planned at this point. It would not have to be started immediately, but could be fitted economically into the workload pattern. Savings from this factor and from prevention of service irregularities would offset the nominal inefficiencies from replacing some contacts somewhat short of their full life.

Also, assuming we have a lot in which the sample shows that some contacts have no metal remaining, the entire lot must then be screened to determine which contacts are to be replaced. If only those now completely worn through are replaced, there is no margin against future wear. The entire operation may then have to be repeated in a short time. We would therefore, want to replace all contacts now below our Conditional Tolerance value. The precision Filar microscope used for sampling is not economical as a wholesale screening gage. Instead, we would use a simple hand magnifier and a visual comparison gage by which the workman would judge the contacts on an attribute basis.

One of the benefits which should result from variables sampling on a continuing basis is the ability to determine rate of wear. It should thus be possible to anticipate when a succeeding sample should be taken on particular contacts. The initial sample will usually not be entirely adequate for this purpose. However, the nature of the distribution plus knowledge of the age of the equipment, and of previous rehabilitation programs, may permit some deductions as to rate of wear.

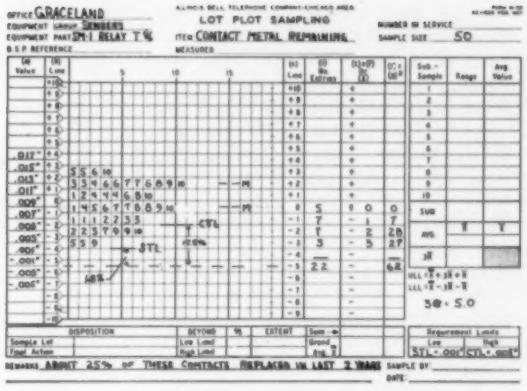

Figure 9—Multi-Modal Distribution (50 Sample Size)

Some Conditions Found in Service

Moderate Wear Rate—Approximately Normal Distribution

In Fig. 5 we see the results of sampling a relay contact on which there has been no over-all replacement program. New original contacts are nominally 0.017 inches thick, and it will be seen that the center of distribution has dropped to about the 0.010 inch level. From the sample it is estimated that some 3 percent of the lot lies below the Conditional Tolerance Limit. This information, related to conditions in the office and the importance of this contact in circuit operation, will enable local management to decide the course of action. The contacts are 15 years old in this particular case, and while no immediate replacement appears urgent, it is evident that these contacts should be watched for further wear.

Extensive Wear—Approximately Normal Distribution

It was mentioned earlier that failure to anticipate the erosion progress will result in wear beyond the Service Tolerance. While it does not necessarily mean that complete contact failure occurs on each operation of the relay, the reliability is so poor that we want to avoid this occurrence on any significant proportion of the relays in service. Figure 6 illustrates a case where the former maintenance philosophy and methods have failed to meet this objective. It will be noted that erosion into the base metal of the contact spring is already taking place. With an estimated 15 percent of the contacts below the Service Tolerance, immediate rehabilitation is obviously necessary. Almost half of the contacts must be replaced now to obtain any margin against further wear.

Moderately Advanced Wear—Skewed Distribution

In Fig. 7 we see a unimodal, nonsymmetrical distribution, with a portion of the sample falling below the Service Tolerance. In such cases

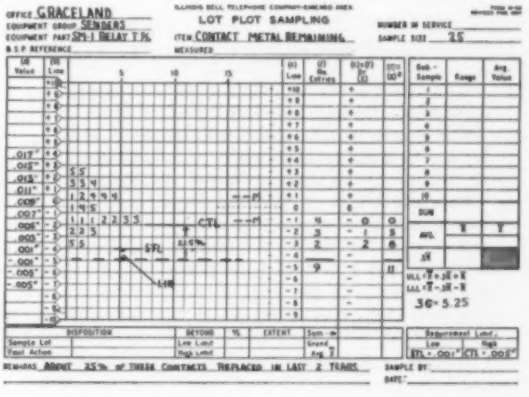

Figure 10—Previous Multi-Modal Distribution Depicted by 25 Size Sample

the Lot Plot method provides for determining the Lot Limit on the basis of distance in cells from the mode. This portion of the sample is considered as one-half of a symmetrical distribution with midpoint at the mode. The theoretical distribution in this case would be 18 cells wide and have a population of 78. The calculated percentage values beyond the Conditional and Service Tolerance Limits are adjusted by a factor of 78/50 to obtain their true proportions of the actual sample.

Again the case is one where immediate action is needed. We have contacts below the Service Tolerance and some are worn into base metal. This is another situation where the erosion progress was not anticipated by the maintenance forces.

Rapid Wear Rate—Multimodal Distribution

The contacts previously discussed have in general reached their present state of wear over a number of years. While individual contacts may have been replaced from time to time, there is no record of any over-all rehabilitation programs. Figure 8 illustrates a much different situation. Here is a contact which wears quite rapidly, requiring partial replacement programs every year or so. Half of these contacts were replaced in the last year, and a clue to the wear rate can thus be obtained by looking at the upper distribution. This mode is centered at 0.012 inches, indicating average wear of 0.005 inches per year. The distribution boundary of these replaced contacts is estimated at about 0.007 inches. On this basis, the life of this contact would be on the order of only two to three years. Action is now needed and it does not appear that replacement of only the contacts that are now 0.005 inches or less would last for a year.

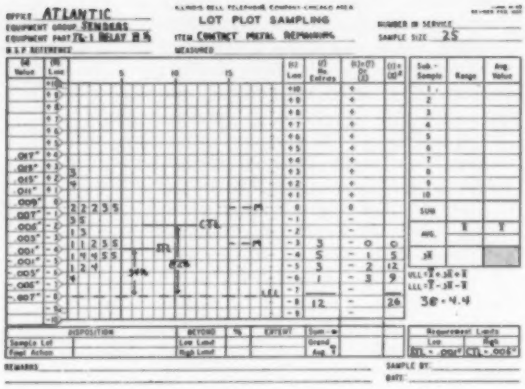

Figure 11—Very Extensive Wear, Multi-Modal Distribution, 25 Sample Size

Usefulness of 25 Sample Size

The purpose of the samples under discussion differs in several respects from the acceptance sampling situation for which the Lot Plot was conceived. There would seem to be no reason, therefore, to consider a 50 unit sample size obligatory if satisfactory precision for our purpose can be obtained with less. While the problem has not been examined from a theoretical standpoint, empirical evidence indicates that 25 would be adequate in most of our situations. The conditions where this applies can be found by analysis of the plot after the 25th sample has been taken. Thus, if 25 samples are not enough for maintenance purposes, the nature and placement of the distribution at this stage should make the deficiency apparent.

Where contacts have been replaced in past rehabilitation programs, a multimodal distribution would be expected in the sample. It is in such distributions that a smaller sample might be found inadequate. Figures 9 and 10 illustrate one of many such situations explored. It will be noted that there is reasonably good agreement in the estimated lot limits and percentages below Conditional and Service Tolerance. This distribution has two main modes as a result of previous replacement projects. Here is a case where the wear has only just reached the danger point. In contrast, Fig. 11 shows a situation where a large majority of the contacts are below tolerance. A sample of 25 seems to have reasonably represented these cases.

Conclusions

There is an excellent application of statistical techniques in the maintenance of telephone equipment. In particular, Variables Sampling will provide a definite picture of equipment wear and deterioration and permit the maintenance people to establish effective and economical rehabilitation programs. Optical measurement facilities are adaptable to determining the extent of contact erosion. Lot Plot sampling plans are suitable for this usage, and give the maintenance forces an adequate and understandable picture. Use of statistical methods minimizes the possibility of excessive service failures and helps to achieve an optimum maintenance program.

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Management's Dilemma*

a discussion of the problems which confront management in assigning quality control's scope of responsibility

ROBERT L. PAPPAS

Ampex Corporation, Redwood City, Calif.

To refer to quality control as "Management's Dilemma" may seem to call for some defense. Webster's definition of dilemma states that it is a situation involving a choice between equally unsatisfactory alternatives. This comment, although rather uncomplimentary, is often symbolic of management's general attitude toward the quality control function. We shall consider in this article some of the factors that prompt such a title.

First of all, let us look at the decision confronting management when it has to determine the scope of responsibility to be assigned to the quality control function. Should it include all factory test and inspection—or should it consist merely of some type of monitoring or audit operation? Should it encompass the responsibility for the design of mechanical gages and electronic test instrumentation—or should it act only in an advisory capacity regarding same? To what extent should quality control concern itself with the basic design of a product—the marketability of a product—the serviceability of a product? And now, the subject of reliability has come on the scene as a major concern to management. Should reliability studies and analyses be a portion of the quality control operation—or should they be assigned to design engineering or some other element of the organization?

On the surface, most of these questions might seem quite easily answered. Yet further thought on our part will reveal otherwise. We shall return to some of them shortly, but for the moment, let us move on to the next large question mark. At this point we may assume that somewhere along the time scale, management has decided that it needs or desires a quality control operation. (Frankly, this can be a broad assumption, inasmuch as many of the giants of industry have not yet seen fit to institute any type of specialized quality control activity.) Now that a management has determined quality control's scope of responsibility, what should be done with the organization resulting from this decision? Should it be placed under some top executive, such as the president or general manager, or should it be assigned to the manufacturing element—or perhaps the engineering department? As long as there is a choice in the matter, let us not ignore the possibility of marketing cognizance—or even the company treasurer, who probably could be expected to live up to tradition and insist that quality control perform miracles without the expenditure of any funds. Furthermore, once the organizational problem is resolved, what level of authority should be granted to the quality control director or manager? Again, these are interesting questions, but on the surface appear to be "old hat" to those of us who have been in the quality control profession for a number of years.

The last series of questions which contribute to management's dilemma has to do with the type of personnel required to manage or administer a quality control program. This matter refers not only to the head of the operation, but also to his subordinate managers and/or supervisors, who often are responsible for sizeable numbers of people and equipment within their respective elements. What type of personnel should management obtain for these positions? Should they be mature, mellowed individuals, with 20 or 25 years experience, and rather conservative in approach, or should they be younger, dynamic, hard-driving men with a more liberal attitude? What type of formal training or education is required? Is a graduate engineer absolutely and positively necessary for the position—or should management select someone with a business or more general supervisory background? Is experience in the company's product line essential—or is it felt that a sufficiently intelligent person will quickly learn the product's idiosyncrasies regardless of his previous experience?

The Questions Remain Unanswered

Now, perhaps, we can begin to see why this situation may be termed "Management's Dilemma." Any answer to any of the previous questions can have its advantages; by the same token, any answer will have its disadvantages. Stating the problem a bit differently, any answer can be satisfactory in some respects and unsatisfactory in others. Referring again to Webster's definition of

*Presented at the Third Annual Inland Empire Quality Control Conference, Riverside, Calif., Jan. 17, 1959. The author, formerly manager of the Ampex Corporation Quality Control Division, has recently been named manager of the Ampex Military Products Company.

dilemma: "a choice between equally unsatisfactory alternatives," let us revise it to read: "a choice between equally *satisfactory* alternatives." Nothing will be lost in real intent by this revision.

It would be foolish to state that there exists a set of approved answers to all of the questions posed. There are probably no theoretically perfect answers to any of the specific questions. These are questions which have been plaguing management ever since the modern quality control function was originally conceived. Most of the questions loom just as large today as they did many years ago. Although no single set of universally correct answers exists, we may draw on experience and observations over the years and offer some general comments regarding the questions relative to the scope of responsibility and placement in the company organization.

First, it has been the author's experience that the quality control function stands a better chance for success if it includes all factory test and inspection operations.

Secondly, the quality control function should not be subordinated to any of the other prime functions in a company, but should be so placed in a company's organizational structure that its head reports to some top executive. Certainly, these same words have been uttered by a countless number of people; therefore, these statements cannot be interpreted as novel. Third and fourth, the fact still stands that the success of any function depends upon the personnel within the function, and it is almost axiomatic that the quality of a product is no better than the quality of the work of the individuals who make it. Quality does not come by happenstance, or even by just the installation of any kind of quality control procedure. It can be secured and maintained only by the everlasting attention to detail by the persons responsible for the design, manufacture and sale of a product from top management to the production worker.

Need for Capable Personnel

However, those of us who raise the hue and cry that quality control should be a separate function, that it should include all test and inspection operations and that it should report to some top management executive, had better realize the significance of this request from all standpoints. The demands upon the quality control function today are becoming greater and greater in magnitude, and more complex in nature. The task of translating complex requirements into simple and practical results has become monumental with no sign of alleviation in sight.

This trend has resulted in a tremendous need for capable, well rounded quality control managers, supervisors, engineers, statisticians, administrators, technicians and what have you; and when we say that we had better recognize the full impact of our request to have the quality control function separate in the organization, to have it include all test and inspection operations, and to have it report to some top executive, it follows that we should also recognize the corollary need for talented, capable quality control personnel.

Gone is the day when the quality control representative had to concern himself only with the acceptability of a part as it was being turned out on a lathe, or the quality of a transformer as received from a supplier. Quality control today consists of budgets, procedures, forms, data processing, management and leadership, statistics, reports, public speaking, administration, social protocol, psychology *and* the acceptability of a part as it is being turned out on a lathe or the quality of a transformer as received from a supplier. There are undoubtedly several more broad requirements that have been overlooked, and this is not a deliberate attempt to subordinate the phase relative to the acceptance or rejection of product. What we *are* indicating, however, is that the breadth and scope of the quality control function as it currently exists is far, far greater than most of us realize and is considerably larger than its status a decade ago.

Quality control has undergone a rapid, but healthy, rate of growth. It is generally accepted by industry, and its people are finally recognized as being something other than just inspectors, but it has reached the stage where another large hurdle has suddenly been encountered along the obstacle course.

One of the most formidable problems facing the quality control profession and management today is the inadequate supply of sufficiently trained and experienced personnel. Indeed, there are many management men who feel that until this problem is solved, the quality control profession will be prevented from attaining its ultimate level of accomplishment. This factor unquestionably contributes very heavily to "management's dilemma," and until we find ways and means of jumping this hurdle, it is likely that much of industry will continue to ignore the benefits that can be reaped from a sound control program. Many companies have attempted to establish quality control organizations within their ranks and have subsequently learned, much to their sorrow, that the program was doomed from its beginning because of lack of capable personnel. Furthermore, these companies met with little success upon searching the open market for talent.

Training Must Be Accelerated

Several quality control organizations have been observed wherein the quality control manager and his subordinates had not the faintest idea of their total cost of operation. Useless purchase of capital equipment, inadequate knowledge of administrative procedures, improper application of statistical techniques and misunderstanding of the interrelationship between quality control and the other operating elements within an organization, all rank high on the list of reasons for failure. Somehow, we must find ways to overcome these basic deficiencies. Obviously the questions posed earlier regarding scope of quality control responsibility and placement of the quality control function within the overall organization become more difficult to answer when management is confronted with the additional problem regarding the unavailability of capable personnel. This is not to imply that the quality control profession as it exists today is a dismal failure, nor that the thousands of people actively engaged in quality control work are incapable of proper performance. Those of us who are part of successful quality control programs know that the job can be done, and is being done, but we need to be concerned about the progress that must be made in the future. We must tremendously accelerate the education, development and training of the people who will be required to cope with our rapidly expanding industrial economy. Not until such time as we have sufficient numbers of people highly skilled in the managerial, administrative and social aspects, as well as the technical phases of quality control, will management really be able to answer some of the questions raised earlier.

What can be done to help ensure that these needs will be met? First of all, our universities and colleges should take steps to produce more well-rounded individuals. Many of our educational institutions have already an-

ticipated the problem and are acting accordingly; however, these are too few in number, and to significantly improve the situation, additional pressures should be brought to bear upon those still offering overly specialized curricula. Secondly, industry's management should take steps to subsidize more in-plant and extra curricular training programs which would, in effect, help their own cause. Third, and perhaps most important, is the fact that there is no substitute for personal motivation on the part of an individual. Chances are high that a person imbued with a strong enough desire to succeed, will succeed. In other words, there are many ways and means to accomplish the end result, and a person desirous of obtaining personal success in the quality control field should undergo self-analysis, properly apply his talents, and in general help propel himself along the road to success.

The Responsibility of Management

Management should not hesitate to assist in every way possible in the area of one's self-improvement. It has already been mentioned that more industrial in-plant and extra curricular training programs would be extremely beneficial. In addition, there should be concentrated effort on the part of those already skilled in various quality control techniques to personally train or in other ways more broadly disseminate the knowledge acquired by years of experience. We must use every means at our disposal to broaden the interests and capabilities of personnel on whom we are depending for the future. To say the least, management must share in the obligation to further develop people interested in quality control-type activities.

Management today is faced with an inadequate supply of not only sufficiently trained, but also experienced personnel. There is a difference between training and experience, for the receipt of formal instruction is significantly different from the know-how gained during actual "under-fire" conditions. Experience is a necessary supplement to training, with its importance as a factor being almost directly dependent upon the level of management being considered.

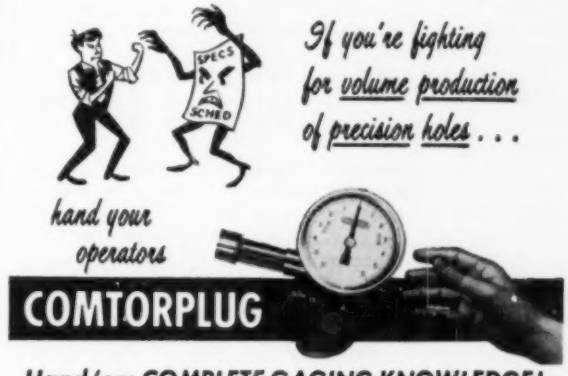
The experience aspect of personnel development can obviously be brought about only by the efforts of management. Opportunities must be provided, assignments made, and actual activities closely monitored and supervised. In some cases, the higher echelons of management have been guilty of criticizing a person for lack of experience, when in reality, that person had never been given the opportunity to gain any experience. This is not to say that management should not be extremely selective regarding personnel considered for promotion or re-assignment, or that they should not be hypercritical regarding a person's past performance, but the fact of the matter is that a man should not be berated for, let us say, lack of supervisory experience if he has never been given the opportunity to supervise.

It has also been indicated that quality control today consists of many elements other than pure testing or inspection. Experience in budgetary controls, management and leadership, reports, public speaking, etc., can only come about by assignments actually incorporating these elements as part of the total position responsibility. It is true that some people are naturally adept at one or more of these elements, but by and large, the average individual acquires these skills only after a period of on-the-job performance; therefore, it is imperative that management provide the opportunities for these skills to be acquired. Furthermore, it is important that an individual be properly supervised while in the process of acquiring these skills, for improper monitoring will often result in the accomplishment of more harm than good.

Opportunity for Skill Development

When we speak of gaining experience in budgetary controls, management and leadership, reports, and public speaking, we must not infer that these skills are to be uniquely associated with quality control activities. These are general skills, and are usually important aspects of any management position. The point to remember is that they are as necessary to the quality control profession as they are to any other area of activity. Fortunately, our nation's economic growth is such that management in general should not find it too difficult to provide ample opportunities for both training and experience. Many companies are now in the process of following the trend toward divisionalization and decentralization because of either expansion or diversification of product line. It is true that this trend is creating a demand for a greater number of experienced personnel; at the same time, however, it should also enable management to provide additional opportunities for personnel to become experienced so that supply can continue to meet future demand. There is no reason why this philosophy should not pertain to the quality control profession, especially if management desires to capitalize on this situation in an optimum fashion.

These are only a few possibilities for quality control personnel development which can and should be exploited. Needless to say, there are others—none of which should be ignored if success is to be assured. Steady, constructive efforts in these directions will do much to help eliminate "management's dilemma."



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Sequential Life Testing Plans for the Exponential Distribution

ALFRED LIEBERMAN

*Institute for Defense Analyses, Washington, D. C.**

Introduction

The sequential plans given in this article are such that equipment with a length of life t_0 or better is accepted at least $1 - \alpha$ proportion of the time, while equipment with a length of life t_1 or worse is rejected $1 - \beta$ proportion of the time.

The sequential plans are based on Wald's[1] work on sequential analysis and the ensuing work on sequential tests for the exponential case done by Epstein and Sobel.[2]

The major advantage of sequential testing plans is that on the average they require less testing than other plans. This is particularly true for very poor or very good material. The major drawback of sequential testing is that the exact number of items needed cannot be determined before the test is run. One can, however, determine the average number of items needed. In general, it will be recognized that good items will be accepted rapidly, while poor items will be rejected rapidly; questionable items will require somewhat more testing.

Applications

The plans given in this report are applicable for life testing of all equipment whose underlying distribution of length of life is given by the *exponential distribution*.

Since it is very costly and difficult to determine if the exponential distribution applies, this fact must often be assumed, based on theory or past data. It has been found, however, that the exponential distribution applies to length of life of many components.[3]

While caution must, therefore, be exercised in the use of these plans, it should be noted that minor deviations from the exponential are not serious for most practical engineering purposes.

Another important feature of these plans is that they can be used either for testing one item at a time or for testing many items at the same time. The decision as to which of these two methods to use depends on the cost of the test items and test set-ups versus the cost of time, as well as upon physical limitations.

Definition of Terms

t_0 = the acceptable length of life

t_1 = the unacceptable length of life

α = the maximum risk of rejecting equipment if its length of life is t_0 or better

β = the maximum risk of accepting equipment if its length of life is t_1 or worse

r = number of failures

TABLE I—Index of Plans

Ratio of $\frac{t_0}{t_1}$	Confidence Coefficients								
	$\alpha = 0.01$ $\beta = 0.01$	$\alpha = 0.01$ $\beta = 0.05$	$\alpha = 0.01$ $\beta = 0.10$	$\alpha = 0.05$ $\beta = 0.01$	$\alpha = 0.05$ $\beta = 0.05$	$\alpha = 0.05$ $\beta = 0.10$	$\alpha = 0.10$ $\beta = 0.01$	$\alpha = 0.10$ $\beta = 0.05$	$\alpha = 0.10$ $\beta = 0.10$
1.5	1A	1B	1C	1D	1E	1F	1G	1H	1I
2.0	2A	2B	2C	2D	2E	2F	2G	2H	2I
3.0	3A	3B	3C	3D	3E	3F	3G	3H	3I

*This article was prepared while the author was on the statistical staff of the Bureau of Ships.

TABLE II

PLAN 1—Factors k_A and k_R, such that $k_A t_0$ gives the required acceptance length of time and $k_R t_0$ the required rejection length of time.

Ratio of $\frac{t_0}{t_1} = 1.5$

No. of Failures	A		B		C		D		E		F		G		H		I	
(r)	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R
0	9.19	....	5.97	....	4.59	....	9.11	....	5.89	....	4.50	....	9.00	....	5.78	....	4.39	....
1	10.0	....	6.78	....	5.40	....	9.92	....	6.70	....	5.31	....	9.81	....	6.59	....	5.20	....
2	10.8	....	7.59	....	6.21	....	10.7	....	7.51	....	6.12	....	10.6	....	7.40	....	6.02	....
3	11.6	....	8.40	....	7.02	....	11.5	....	8.32	....	6.94	....	11.4	....	8.21	....	6.83	....
4	12.4	....	9.22	....	7.83	....	12.4	....	9.13	....	7.75	....	12.2	....	9.02	....	7.64	....
5	13.2	....	10.0	....	8.64	....	13.2	....	9.94	....	8.56	....	13.1	....	9.84	....	8.45	....
6	14.1	....	10.8	....	9.45	....	14.0	....	10.8	....	9.37	....	13.9	0.281	10.6	0.363	9.26	0.472
7	14.9	....	11.6	....	10.3	....	14.8	....	11.6	....	10.2	....	14.7	1.09	11.5	1.17	10.1	1.28
8	15.7	....	12.5	....	11.1	....	15.6	0.517	12.4	0.599	11.0	0.707	15 5	1.90	12.3	1.98	10.9	2.09
9	16.5	....	13.3	....	11.9	....	16.4	1.33	13.2	1.41	11.8	1.52	16.3	2.71	13.1	2.80	11.7	2.90
10	17.3	....	14.1	....	12.7	....	17.2	2.14	14.0	2.22	12.6	2.33	17.1	3.52	13.9	3.61	12.5	3.72
15	21.4	2.98	18.1	3.06	16.8	3.16	21.3	6.19	18.1	6.28	16.7	6.38	21.2	7.58	17.9	7.66	16.6	7.77
20	25.4	7.03	22.2	7.11	20.8	7.22	25.3	10.2	22.1	10.3	20.7	10.4	25.2	11.6	22.0	11.7	20.6	11.8
25	29.5	11.1	26.2	11.2	24.9	11.3	29.4	14.3	26.2	14.4	24.8	14.5	29.3	15.7	26.1	15.8	24.7	15.9
$k_A =$	$9.190+0.811r$		$5.971+0.811r$		$4.585+0.811r$		$9.108+0.811r$		$5.889+0.811r$		$4.503+0.811r$		$9.000+0.811r$		$5.781+0.811r$		$4.394+0.811r$	
$k_R =$	$-9.190+0.811r$		$-9.108+0.811r$		$-9.000+0.811r$		$-5.971+0.811r$		$-5.889+0.811r$		$-5.781+0.811r$		$-4.585+0.811r$		$-4.503+0.811r$		$-4.394+0.811r$	

TABLE III

PLAN 2—Factors k_A and k_R, such that $k_A t_0$ gives the required acceptance length of time and $k_R t_0$ the required rejection length of time.

Ratio of $\frac{t_0}{t_1} = 2$

No. of Failures	A		B		C		D		E		F		G		H		I	
(r)	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R	k_A	k_R
0	4.60	....	2.99	....	2.29	....	4.55	....	2.94	....	2.25	....	4.50	....	2.89	....	2.20	....
1	5 29	....	3.68	....	2.99	....	5.25	....	3.64	....	2.94	....	5.19	....	3.58	....	2.89	....
2	5.98	....	4.37	....	3.68	....	5.94	....	4.33	....	3.64	....	5.89	....	4.28	....	3.58	....
3	6.67	....	5.06	....	4 37	....	6.63	....	5.02	....	4.33	....	6.58	....	4.97	....	4.28	....
4	7.37	....	5.76	....	5.06	....	7.33	....	5.72	....	5.02	....	7.27	0.479	5.66	0.521	4.97	0.575
5	8.06	....	6.45	....	5.76	....	8.02	....	6.41	0.521	5.72	0.575	7.96	1.17	6.36	1.21	5.66	1.27
6	8.75	....	7.14	....	6.45	....	8.71	1.17	7.10	1.21	6.41	1.27	8.66	1.86	7.05	1.91	6 36	1.96
7	9.45	0.256	7.84	0.297	7.14	0.351	9.40	1.86	7.80	1.91	7.10	1.96	9.35	2.56	7.74	2 60	7.05	2.65
8	10.1	0.949	8.53	0.990	7 84	1.04	10.1	2.56	8.49	2.60	7.80	2 65	10.0	3.25	8.43	3.29	7.74	3.35
9	10.8	1.64	9.22	1.68	8.53	1.74	10 8	3.25	9.18	3.29	8.49	3.35	10.7	3.94	9.13	3.99	8.43	4.04
10	11.5	2.34	9 92	2.38	9.22	2.43	11.5	3.94	9.87	3.99	9.18	4.04	11.4	4.64	9.82	4.68	9.13	4.73
15	15.0	5.80	13.4	5.84	12.7	5.90	14.9	7.41	13.3	7.45	12 6	7.50	14.9	8.10	13 3	8.14	12 6	8.20
20	18.5	9.26	16.8	9.31	16 2	9.36	18.4	10.9	16.8	10.9	16.1	11.0	18.4	11.6	16.8	11.6	16.1	11.7
25	21.9	12.7	20.3	12.8	19.6	12.8	21.9	14.3	20.3	14.4	19.6	14.4	21.8	15.0	20.2	15.1	19.5	15.1
$k_A =$	$4.595+0.693r$		$2.986+0.693r$		$2.233+0.693r$		$4.554+0.693r$		$2.944+0.693r$		$2.251+0.693r$		$4.500+0.693r$		$2.890+0.693r$		$2.197+0.693r$	
$k_R =$	$-4.595+0.693r$		$-4.554+0.693r$		$-4.500+0.693r$		$-2.986+0.693r$		$-2.944+0.693r$		$-2.890+0.693r$		$-2.293+0.693r$		$-2.251+0.693r$		$-2.197+0.693r$	

Plans

All the plans are computed on the basis of $t_0 = 1$. Hence they can be used for any value of t_0 by multiplying the factors k in the plans by the appropriate t_0. Table I gives an index of the plans.

Plans have been developed for three ratios of $\frac{t_0}{t_1}$; these are as follows:

Plan 1: $\frac{t_0}{t_1} = 1.5$ (see Table II)

Plan 2: $\frac{t_0}{t_1} = 2$ (see Table III)

Plan 3: $\frac{t_0}{t_1} = 3$ (see Table IV)

For each of these three ratios, plans have been made for nine combinations of α and β. These are as follows:

	α	β
A	0.01	0.01
B	0.01	0.05
C	0.01	0.10
D	0.05	0.01
E	0.05	0.05
F	0.05	0.10
G	0.10	0.01
H	0.10	0.05
I	0.10	0.10

Each plan can therefore be identified by a combination of a number and a letter, i.e., Plan 2A means that the ratio of $\frac{t_0}{t_1} = 2$, $\alpha = 0.01$ and $\beta = 0.01$. In addition to this information, however, the value of either t_0 or t_1 must also be specified to identify a specific plan. The full identification of a plan, therefore, would be: Plan 2A (t_0 = 1000 hrs.). This plan would mean that the acceptable length of life (t_0) is 1000 hours with a risk of rejection (α) of 0.01, and the unacceptable length of life (t_1) is 500 hours with a risk of acceptance (β) of 0.01.

It should be noted that in Tables II, III, and IV equations are given at the bottom of each plan to permit the computation of the k values for values of r not given in the tables.

The average sample numbers for each plan have been computed for five values of t ($t = 0, t_1, s, t_0, \infty$). These values are given in Table V. In addition, a summary of Table V is given in Table VI for the use of the experimenter. It should be noted, however, that while these tables give average sample sizes, individual tests will require more or less items.

The operating characteristic curves give the probability of accepting the test items. This probability depends on the length of life of the item population (that is, the true average life of the items). Table VII gives five points on the operating characteristic curve of all the plans.

Selection of Plans

An engineer wishing to select a plan must first decide on the values of t_0, t_1, α and β he wants to use. It should be noted that this selection is not entirely free as it is limited by the extent of the plans presented in this re-

TABLE IV

PLAN 3—Factors k_A and k_B, such that $k_A t_0$ gives the required acceptance length of time and $k_B t_0$ the required rejection length of time.

Ratio of $\frac{t_0}{t_1} = 3$

No. of Failures (r)	A		B		C		D		E		F		G		H		I	
	k_A	k_B	k_A	k_B	k_A	k_B	k_A	k_B	k_A	k_B	k_A	k_B	k_A	k_B	k_A	k_B	k_A	k_B
0	2.30	....	1.49	....	1.15	....	2.28	....	1.47	....	1.13	....	2.25	....	1.44	....	1.10	....
1	2.85	....	2.04	....	1.70	....	2.83	....	2.02	....	1.68	....	2.80	....	1.99	....	1.65	....
2	3.30	....	2.59	....	2.24	....	3.38	....	2.57	....	2.24	....	3.35	....	2.54	....	2.20	....
3	3.94	....	3.14	....	2.79	....	3.92	0.154	3.12	0.175	2.77	0.202	3.90	0.501	3.09	0.521	2.75	0.548
4	4.49	....	3.69	....	3.34	....	4.47	0.703	3.67	0.724	3.32	0.751	4.45	1.05	3.64	1.07	3.30	1.10
5	5.04	0.447	4.24	0.468	3.89	0.495	5.02	1.25	4.22	1.27	3.87	1.30	5.00	1.60	4.19	1.62	3.81	1.65
6	5.59	0.996	4.79	1.02	4.44	1.04	5.57	1.83	4.77	1.82	4.42	1.85	5.54	2.15	4.74	2.17	4.39	2.20
7	6.14	1.54	5.34	1.57	4.99	1.59	6.12	2.35	5.32	2.37	4.97	2.40	6.09	2.70	5.29	2.72	4.94	2.74
8	6.69	2.09	5.88	2.12	5.54	2.14	6.67	2.90	5.86	2.92	5.52	2.95	6.64	3.25	5.84	3.27	5.49	3.29
9	7.24	2.64	6.43	2.66	6.09	2.69	7.22	3.45	6.41	3.47	6.07	3.50	7.19	3.80	6.39	3.82	6.04	3.84
10	7.79	3.19	6.98	3.21	6.61	3.24	7.77	4.00	6.96	4.02	6.62	4.04	7.74	4.34	6.94	4.36	6.59	4.39
15	10.5	5.94	9.73	5.96	9.38	5.98	10.5	6.74	9.71	6.76	9.36	6.79	10.5	7.09	9.68	7.11	9.33	7.14
20	13.3	8.68	12.5	8.70	12.1	8.73	13.3	9.49	12.5	9.51	12.1	9.54	13.2	9.83	12.4	9.85	12.1	9.88
25	16.0	11.4	15.2	11.4	14.9	11.5	16.0	12.2	15.2	12.3	14.9	12.3	16.0	12.6	15.2	12.6	14.8	12.6
$k_A =$	$2.298+0.549r$		$1.493+0.549r$		$1.146+0.549r$		$2.277+0.549r$		$1.472+0.549r$		$1.126+0.549r$		$2.250+0.549r$		$1.445+0.549r$		$1.099+0.549r$	
$k_B =$	$-2.298+0.549r$		$-2.277+0.549r$		$-2.250+0.549r$		$-1.493+0.549r$		$-1.472+0.549r$		$-1.445+0.549r$		$-1.146+0.549r$		$-1.126+0.549r$		$-1.099+0.549r$	

TABLE V—Average Sample Number for Each Plan

Average length of life of population (t)	Average Sample Number Needed to Reach Decision (r)								
	A	B	C	D	E	F	G	H	I
Plan 1									
0	12.0	12.0	12.0	8.0	8.0	8.0	6.0	6.0	6.0
$t_1 = 0.667t_0$	62.6	58.0	53.1	40.4	36.8	33.0	30.4	27.7	24.4
$s = 0.811t_0$	128.6	82.8	62.8	82.8	52.7	39.6	62.8	39.6	29.4
t_0	47.6	30.8	23.5	44.1	28.0	21.1	40.4	25.1	18.6
∞	0	0	0	0	0	0	0	0	0
Plan 2									
0	7.0	7.0	7.0	5.0	5.0	5.0	4.0	4.0	4.0
$t_1 = 0.500t_0$	23.3	21.6	19.8	15.1	13.7	12.3	11.5	10.3	9.1
$s = 0.693t_0$	44.0	28.3	21.5	28 3	18.1	13.6	21.5	13.6	10.1
t_0	14.7	9.5	7.2	13.6	8.6	6.5	12.4	7.7	5.7
∞	0	0	0	0	0	0	0	0	0
Plan 3									
0	5.0	5.0	5.0	3.0	3.0	3.0	3.0	3.0	2.0
$t_1 = 0.333t_0$	10.4	9.6	8.8	6.7	6.1	5.5	5.1	4.6	4.1
$s = 0.549t_0$	17.5	11.2	8.5	11.2	7.2	5.4	8.5	5.4	4.0
t_0	5.0	3.2	2.5	4.6	2.9	2.2	4.2	2.6	2.0
∞	0	0	0	0	0	0	0	0	0

port. The selection, however, is wide enough for almost all applications. The selection of these four values determines a plan as outlined above (see Plans). We can now go to Table VI and find the average sample size needed and to Table VII to determine the operating characteristics of this plan.

The specific plan can then be obtained by selecting the appropriate plan in Table II, III, or IV and multiplying the k factors for acceptance and rejection by t_0. This gives the acceptance and rejection criteria for the total length of test life (life of item 1 + life of item 2 + ... + life of item r) for the number of failures (r).

TABLE VI—Average Sample Size Needed*

	A	B	C	D	E	F	G	H	I
Plan 1	63	58	53	58	37	33	31	28	24
Plan 2	23	22	20	15	14	12	11	10	9
Plan 3	10	10	9	7	6	6	5	5	4

**It should be noted while these are average sample sizes, individual tests will require more or less items. The maximum number of items needed may be as high as 2 to 3 times the average sample size.*

These values can then be put in the form of a table or chart, as will be shown in the example.

The length of life of each item and the cumulative length of life of all the items is recorded as the test progresses. The sum of the item length of life is then compared to the acceptance and rejection numbers. When for any given number of failures the length of life exceeds the accept limit, the items are acceptable; when for any given number of failures it is less than the reject line, the items are rejected; if it is between the two lines no decision is made and testing continues.

Construction of Plans

The parameters of the plans are:

(1) h_0 : the intercept of the acceptance line
(2) h_1 : the intercept of the rejection line
(3) s : the slope of the lines
(4) L(t) : the probability of acceptance
(5) $E_t(r)$: the average sample number

These parameters were computed based on the following formula developed from Epstein and Sobel's work. Note that Accept Line = $h_0 + sr$ and Reject Line = $-h_1 + sr$.

$$(1)\quad h_0 = \frac{-\ln B}{\frac{1}{t_1} - \frac{1}{t_0}} \qquad \text{where } B = \frac{\beta}{1-\alpha}$$

$$(2)\quad h_1 = \frac{\ln A}{\frac{1}{t_1} - \frac{1}{t_0}} \qquad \text{where } A = \frac{1-\beta}{\alpha}$$

$$(3)\quad s = \frac{\ln \frac{t_0}{t_1}}{\frac{1}{t_1} - \frac{1}{t_0}}$$

$$(4)\quad L(t) = \frac{A^h - 1}{A^h - B^h} \qquad \text{where } t = \frac{\left(\frac{t_0}{t_1}\right)^h - 1}{h\left(\frac{1}{t_1} - \frac{1}{t_0}\right)}$$

and is determined by assigning values to h and solving for t and L(t).

$$(5)\quad E_t(r) \cong \left[\frac{h_1 - L(t)(h_0 + h_1)}{s - t}\right] \quad \text{for } t \neq s$$

$$\cong \frac{h_0 h_1}{s^2} \quad \text{for } t = s$$

Example

In the life testing of a given power tube, it has been decided that the acceptable length of life is 1000 hours and the unacceptable length of life is 500 hours.

$$\left(\frac{t_0}{t_1} = \frac{1000}{500} = 2\right)$$

It is decided to take a risk (α) of 0.05 of rejecting tubes with a life over 1000 hours and a risk (β) of 0.10 of accepting tubes with a life of less than 500 hours. We find that the plan for this test is Plan 2F ($t_0 = 1000$ hours).

In Table III under Plan 2F, we find the k values for the determination of the accept and reject limits. They are as follows:

No. of Failures (r)	Acc (k_A)	Accept Limit ($k_A t_0 = 1000 k_A$)	R3 (k_R)	Reject Limit ($k_R t_0 = 1000 k_R$)
0	2.25	2,250	—	—
1	2.94	2,940	—	—
2	3.64	3,640	—	—
3	4.33	4,330	—	—
4	5.02	5,020	—	—
5	5.72	5,720	0 575	575
6	6.41	6,410	1.27	1,270
7	7.10	7,100	1.96	1,960
8	7.80	7,800	2.65	2 650
9	8.49	8,490	3 25	3,350
10	9.18	9,180	4.04	4,040
15	12.6	12,600	7.50	7,500
20	16.1	16,100	11.0	11,000
25	19.6	19,600	14.4	14,400

TABLE VII—Operating Characteristics

Average length of life of population			Probability of Acceptance								
Plan 1	Plan 2	Plan 3	A	B	C	D	E	F	G	H	I
0	0	0	0	0	0	0	0	0	0	0	0
$t_1 = 0.667t_0$	$t_1 = 0.500t_0$	$t_1 = 0.333t_0$	0.01	0.05	0.10	0.01	0.05	0.10	0.01	0.05	0.10
$0.811t_0$	$0.693t_0$	$0.549t_0$	0.50	0.604	0.662	0.396	0.50	0.562	0.338	0.438	0.50
t_0	t_0	t_0	0.99	0.99	0.99	0.95	0.95	0.95	0.90	0.90	0.90
∞	∞	∞	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

The accept and reject limits can be put in table form, such as Table VIII, or graph form such as Fig. 1. As can be seen, the decision to accept is made between the tenth and eleventh failure. Table III does not give values for k_A and k_R for $r = 11$. These values, however, can be obtained by means of the equations given in Table III under Plan 2F.

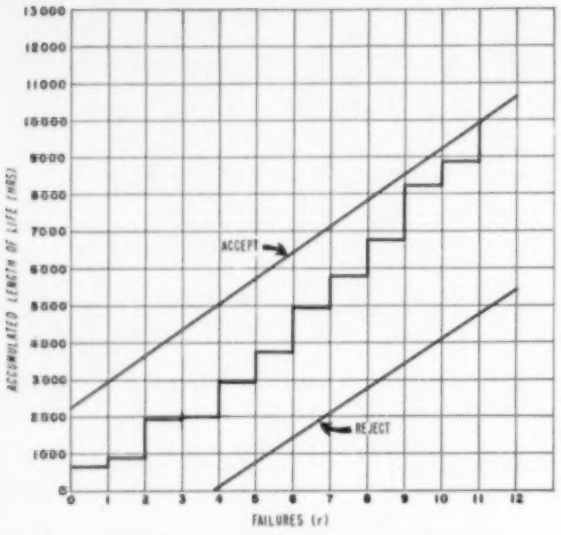

Figure 1—Graphical Presentation of Plan 2F ($t_0 = 1000$ hrs)

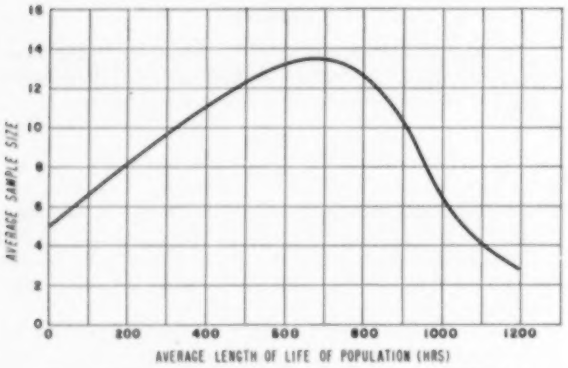

Figure 2—Average Sample Size for Plan 2F ($t_0 = 1000$ hrs)

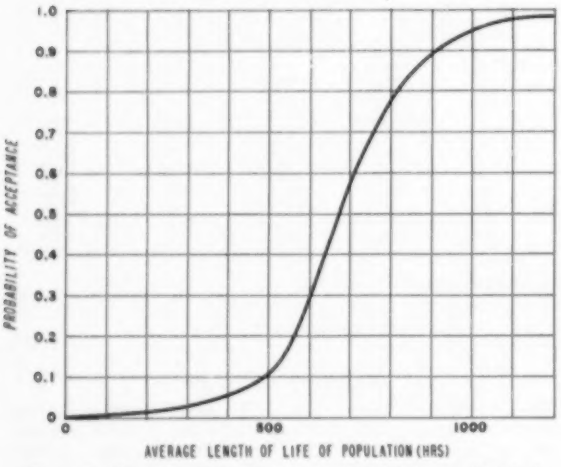

Figure 3—Operating Characteristic for Plan 2F ($t_0 = 1000$ hrs)

TABLE VIII—Example for Plan 2F ($t_0 = 1000$ hrs)

No. of Failures (r)	Length of Life (hrs)	Accumulated Length of Life (hrs)	Accept (hrs)	Reject (hrs)
0	624	624	2,250	...
1	223	847	2,940	...
2	1,096	1,943	3,640	...
3	38	1,981	4,330	...
4	947	2,928	5,020	...
5	784	3,712	5,720	575
6	1,249	4,961	6,410	1,270
7	840	5,801	7,100	1,960
8	982	6,783	7,800	2,650
9	1,471	8,254	8,490	3,350
10	638	8,892	9,180	4,040
11	978*	9,870	9,870	4,730

*The test is stopped and the tubes are accepted.

For $r = 11$

$$k_A = 2.251 + 0.693(11) = 9.87$$

$$k_R = -2.890 + 0.693(11) = 4.73$$

The accept and reject limit for $r = 11$ are, therefore, 9870 and 4730 hours, respectively.

The average sample size of Plan 2F ($t_0 = 1000$ hours) obtained from Table VI, is 12. The entire average sample number curve, is shown in Fig. 2. This curve is obtained by tracing a line through the five points given in Table V under Plan 2F. These are as follows:

Average Length of Life of Population ($t_0 = 1000$ hours)		Average Sample Number
0	0	5.0
$0.500t_0$	500 hours	12.3
$0.693t_0$	693 hours	13.6
t_0	1000 hours	6.5
∞	∞	0

The operating characteristic curve of Plan 2F ($t_0 = 1000$ hours) is shown in Fig. 3. This curve is obtained by tracing a line through the five points given in Table VII under Plan 2F. These are as follows:

Average Length of Life of Population ($t_0 = 1000$ hours)		Probability of Acceptance
0	0	0
$0.500t_0$	500 hours	0.10
$0.693t_0$	693 hours	0.562
t_0	1000 hours	0.95
∞	∞	1.00

Acknowledgment

The author gratefully acknowledges the assistance given him by Mrs. Mary R. Kulin through her valuable assistance in the preparation of the tables and charts.

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(1) Wald, A., *Sequential Analysis*, John Wiley and Sons, Inc., New York, 1957

(2) Epstein, B. and Sobel, M., "Sequential Life Tests in the Exponential Case," *Annals of Mathematical Statistics*, Vol. 26 (1955), p. 82-93

(3) Davis, D. J., "An Analysis of Some Failure Data," *Journal of the American Statistical Association*, 47 (1952), p. 113-150

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From the Scrap Box

MASON S. WESCOTT, *Editor*

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December 1, 1958

Dr. Mason E. Wescott
University College
Rutgers University
New Bruswick, New Jersey

Dear Dr. Wescott:

In the article "Who Controls Quality—And How?" (Oct. 1958, p. 18-21), it was requested that other ideas which occur to readers be submitted in letters to the Editor of *Industrial Quality Control*. This letter is a tabulation of various ideas which have been contributed to the author since publication time.

It has also been pointed out that cost generated by poor quality of purchased parts may properly be charged to Quality Control in those instances where there is a quality control vendor rating or certification plan and the poor quality was manufactured by a certified or favorably rated vendor.

Contributed by Chester Gadzinski, Raytheon Manufacturing Company

Purchasing

8. Make sure that clear quality requirements have been spelled out for the vendor, including all referenced specifications.

   Not only should the vendor have such information, but he must understand it and be in a position to make use of it.

Contributed by Thomas Burleson, Mahoning Glass Works, General Electric Company

Production

8. Establish and operate adequate schedules of equipment maintenance.

   Use quality data feedback to establish procedures, frequencies, and modifications thereof.

Contributed by Leroy Lindgren, Joy Manufacturing Company

Industrial Engineering

4. Keep Process Sheets up-to-date.

   Unless Process Sheets are being followed by operators, the process is not under control. Unless they can be followed, the process cannot be controlled.

5. Maintain rational relations between piece tolerances and tool tolerances.

   Rational relations can be established by a competent Quality Control Engineer.

Contributed by Richard Jacobs, Sylvania Electric Products, Incorporated

Sales

4. In negotiating contracts aim for realistic requirements.

   Environmental requirements should be realistic and verifiable. Reliablity requirements should be realistic and verifiable. Sufficient funds and sufficient time should be provided to attain these goals.

Contributed by the Original Author

Design

5. Appreciate simplicity of design.

   Avoid "supercolossal gadgetry." It may be better to build equipment which will do some things automatically all the time than equipment which will do all things automatically some of the time.

Production Control

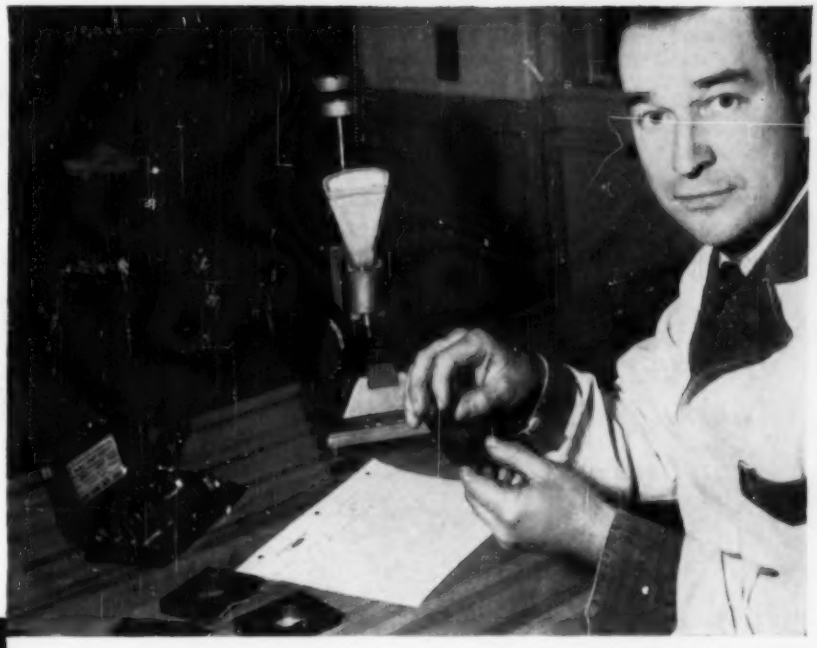
5. Provide realistic priority lists for receiving inspection departments.

   If a high percentage of items is labeled "URGENTLY NEEDED," none of the items will receive urgent handling.

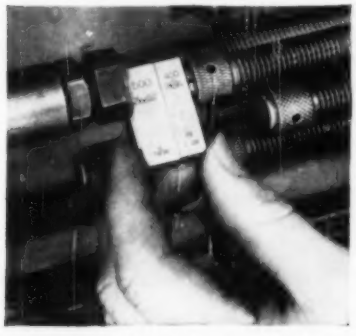
Warren R. Purcell
Director of Quality Control

NEW!

DoALL 56-R GAGE BLOCK SET



A single block can be used as either "go" or "not go" gage to measure this snap ring groove.



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Density Control

by weight and dimensional measurement control

RICHARD S. BINGHAM, JR.

The Carborundum Company, Niagara Falls, N. Y.

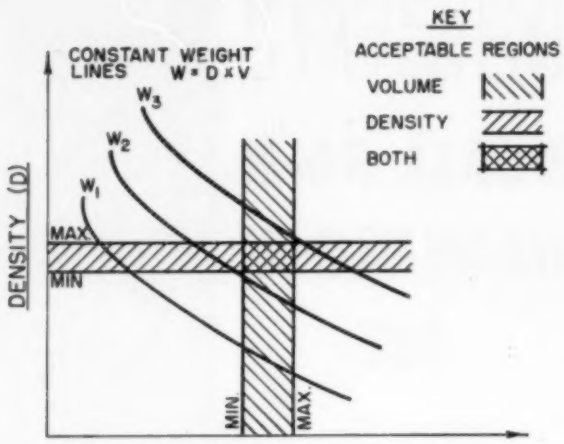

Figure 1—Density vs Volume

Introduction

How can control be guaranteed on product density when it cannot be measured directly? This note describes a process control procedure using product weight and dimensional inspection information to assure density control. The method is suitable to other properties which cannot be measured directly, to solids with a regular figure or to solids whose volume can be mathematically determined from inspection measurements by calculation, and where a process control tool is needed.

In this problem, minimum and maximum specifications had to be met for dimensions and density for each production unit, called a "piece." It was not possible to find piece density directly; however, piece weight and dimensions could be measured and piece volume calculated from inspection measurements.* From the fundamental definition of density, d = w/v (weight divided by volume), it can be seen that a plot of density versus volume for given weights shows a family of hyperbolas. (See Fig. 1.) Each piece is required to satisfy maximum and minimum specifications on volume and density; the rectangular area indicates the region which satisfies *both* volume and density specifications. Figure 2 shows this acceptance region in greater detail for some hypothetical specifications.* Prior to sketching the density-volume relation, attempts had been made by the production foreman to calculate maximum and minimum weights which would guarantee density. The foreman had calculated maximum weight = $d_{max} \times v_{max}$ (line T in Fig. 2), and minimum weight = $d_{min} \times v_{min}$ (line B), but could not understand why calculated weights from $d_{min} \times v_{max}$ (line L) and $d_{max} \times v_{min}$ (line U) would not confirm these. These are shown in Table I. The graphs also showed that using weights corresponding to "L" and "U" would unnecessarily restrict the process to only 65 percent of the available operating area as defined by the density-volume specifications. What practical control procedure could be developed from this knowledge?

*In some cases, density can be determined by immersion in a common fluid such as water or mercury. In this particular problem this was not feasible. An alternative approach, packing in sand or other small particle solid, was considered but found too time consuming and unreliable. Also, the abrasive nature of the sand was detrimental to the product surface finish.

A Weight-Dimension Inspection Procedure

An inspection plan was devised which used piece weight to decide *first*, whether to inspect, and, *secondly*, whether to calculate density.

The steps were:

1. *Weigh each piece* and record weight (W)
   (a) Reject if weight is greater than "T" or less than "B"†
   (b) Classify "weight-O.K." if weight is equal to or less than "U" *and* equal to or greater than "L"
   (c) Classify "check-density" if weight is
      1. less than "T" but greater than "U" *or*
      2. less than "L" but greater than "B"
2. *Inspect for dimensions those pieces from 1 (b) and 1 (c).*
   (a) Accept those from 1 (b) if within dimensional specs; otherwise Reject
   (b) Approve "for calculation" those from 1 (c) if within dimensional specs
   (c) Otherwise Reject
3. *Calculate piece density from piece weight and inspection dimensions for pieces from step 2 (b).*
   (a) Accept pieces whose densities are within specs
   (b) Otherwise Reject

Figure 3 is a schematic diagram of the plan.

The plan could have been reversed, with inspection preceding

*Over these short ranges straight lines approximate the hyperbola adequately.

†Note that the lines "T", "U", "L", "B", each represent a constant weight for a variety of density-volume conditions.

TABLE I—Weights Calculated From Density-Volume Combinations

	Density (g/cc)	
Volume* (cc)	Minimum 1.00	Maximum 1.08
Minimum 6700	6700 B	7236 U
Maximum 6880	6880 L	7430 T

*Density specified, volumes calculated from blueprints. "T, U, L, B" refer to Fig. 2, and are weight limits in grams.

weighing. However, the cost of weighing was minute compared to the gaging operations involved. Also, the weighing could be put on a "inspect-reject" basis using the absolute maximum weight ("T") and the absolute minimum weight ("B").

Density calculation was a necessary plan requirement, since in two volume-weight regions it was not possible to classify the product unambiguously. If the piece weight fell between "T" and "U" or "B" and "L", even with the knowledge that the unit was acceptable for dimensions, it was still uncertain whether its density was in one of the reject regions R_1 or R_2, or in the acceptable regions Q_1 or Q_2. (Piece inspection did *not* determine the actual piece volume but rather that each individual unit met the dimensional requirements; hence it could only be claimed that the volume fell between the minimum and the maximum. Thus volume calculation was essential.)

Calculating Volume on a High Speed Computer

In many situations, volumes calculated from various combinations of dimensions can be tabulated. Or alternatively, nomographs or slide rules can be devised for rapid computation. However, in this particular problem, over 15 measurements were involved per piece. Furthermore, with complicated shapes it frequently becomes difficult to find nomographic scales adequately accurate for multi-component calculation especially when the tolerances are small compared to the dimensions. Hence it was decided to perform the calculations on the Univac.®** The coding was prepared through the use of Remington-Rand's automatic programming routine, Math-Matic.* The program checked the dimensions for each piece against its own specification before computing the volume. It also selected the appropriate formula for each of a number of products. Computing time was not more than 0.5-1.0 minutes (as compared with one hour by hand calculation), or about $0.75 per piece.

Influence on Process and Product Design

Once this procedure had been set up and examined, it became obvious that the original process design, in which the composition of the material had been set, had so formulated

*See "Carborundum Uses of Math-Matic" by R. S. Bingham, Jr., *Univac Review*, Vol. 2, No. 2, page 4.

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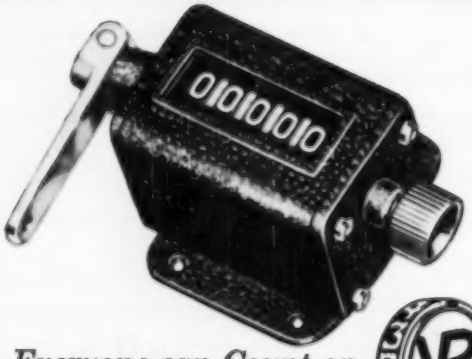

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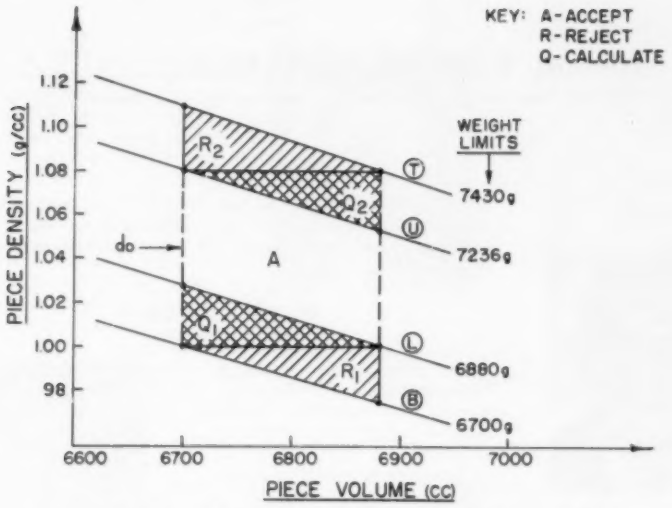


Figure 2—Accept-Reject Region for Density Based on Volume-Weight

the product that the entire volume-density acceptance region was not usable. (The choice of constituents made densities lower than 1.04 g/cc impossible.) Thus, it became evident that a different ingredient choice must be made to achieve densities below $d_0 = 1.04$.* (See Fig. 2). The significance became even clearer when difficulty in satisfying the specifications became apparent. Hence, graphically establishing the problem in terms of Fig. 2 led to a better understanding of the design requirements for the process.

In this particular application, control was prescribed by examining individual weights of pieces on an individual's control chart. The important point to be noted, however, is not the use of the control chart but rather the definition of the control limits—in this case, the specification lines indicated as "B", "L", "U" and "T", Fig. 2, within which the weight must be controlled in order to obtain adequate density. Thus a combination of engineering principles, calculation on a high speed computer, and the concepts of modern statistical quality control led to a satisfactory acceptance inspection procedure for a rather difficult problem.

*In essence, two other constant weight lines then controlled. These were 6968 g and 7155 g based on $d_0 \times v_{min}$ and $d_0 \times v_{max}$ and equivalent to "B" and "L" respectively in effect. Thus only one-half the acceptable specification area could be utilized by the existing process. Furthermore, under these conditions failure to use the "weigh-inspect-calculate" procedure would further reduce this to only 30 percent.

Acknowledgement

The author wishes to thank Dr. E. R. Ott, Mr. V. B. Shelburne and Mr. J. L. Gioele for several suggestions, and The Carborundum Company for permission to publish this article.

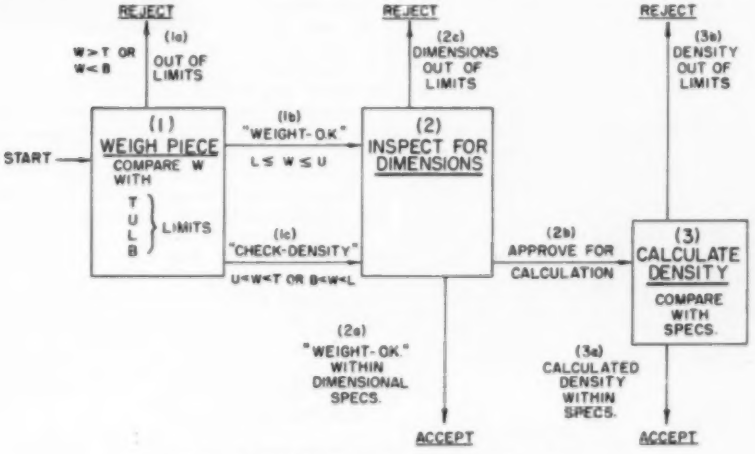
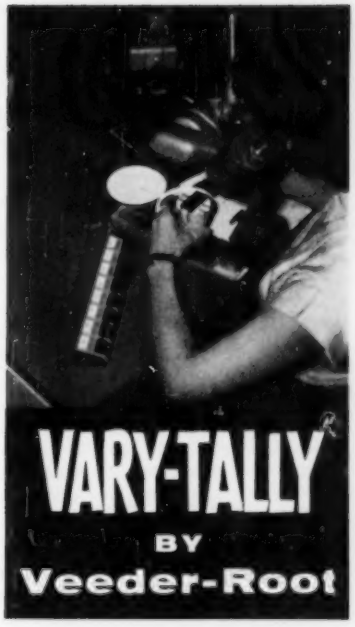


Figure 3—Weight Dimension Inspection Procedure



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He is co-editor of the Problems Department of *Industrial Quality Control*, and has written several articles on QC and statistics.

A member of the Metropolitan section, he has held various ASQC offices. He has appeared as a guest speaker at numerous section meetings, conferences and conventions of ASQC as well as of other professional societies.

Mr. Budne is an independent consultant in statistical engineering and quality control, and is also a member of the Institute of Mathematical Statistics, ASA, and the Biometrics Society.

H. B. EPSTEIN
Dallas-Fort Worth section

Mr. Epstein received his B. S. in aeronautical engineering from New York University and is a registered professional engineer.

He has held several executive positions with his section, and was 1956-57 chairman of the Aircraft and Missile Division.

Currently Mr. Epstein is general chairman of the Seventh Annual Aircraft and Missile Division Conference to be held in Dallas in November.

He has published several papers in the field of quality control including the AIA-ASQC Survey Report, "Quality Control's Role in Reliability."

Since 1946 he has been in QC at Chance Vought Aircraft. At present he is chief of the quality and reliability development section of the QC department.

GLEN GHORMLEY
Los Angeles section

Mr. Ghormley is supervisor of management service at Cannon Electric Co., where he guides the firm's long range planners.

He is also a fellow of the ASA, and a member of the Southern California Academy of Sciences, National Management Association, American Society for the Advancement of Science, the Institute of Management Science, American Management Association, and the Operations Research Society of America.

Mr. Ghormley has written many papers, including a textbook. Among his proudest accomplishments is that of having been named "Plug of the Month," an award given by fellow management people for outstanding service to their company, their management club, and their community and educational pursuits.

WILLIAM A. GOLOMSKI
Milwaukee section

Mr. Golomski has attended Wisconsin State College, Marquette University, St. Louis University, the University of Chicago, and the Virginia Polytechnic Institute. In addition, he has taught at Wisconsin State College, Marquette University, St. Louis University, and the University of Wisconsin.

He is chairman of the Saddoris Award committee, past president of the Milwaukee chapter of ASA, a past chairman of the Milwaukee section of ASQC, president of the Wisconsin Mathematics council, a member of the Board of Advisors of Schools of Education, University of Wisconsin, Madison and Milwaukee.

Mr. Golomski is author of numerous articles on management, QC, mathematics education, marketing and market research, operations research, production, and statistics in food industries.

At present he is manager, operations research, Oscar Mayer & Co., Madison, Wis.

BERNARD HECHT
Los Angeles section

Mr. Hecht received his Bachelor of Science in Electrical Engineering from CCNY, New York, and his Master of Science in Electrical Engineering from the Moore School, University of Pennsylvania.

He was a founding member of ASQC and founder and chairman of the Los Angeles chapter of the Professional Group on Reliability and QC of the IRE. He is nationally known for work in electronic component part reliability and quality improvement.

His experience includes QC engineering and management with the government during WW II. Following this he managed QC programs at the International Resistance Co., and RCA.

Later he was works and general manager at smaller firms, and this led to the establishment of his consulting practice in 1952.

Mr. Hecht moved his office to the West Coast in 1953. His list of clients includes Sprague Electric Co., Hughes Aircraft Co., Motorola, Inc., Lockheed Aircraft Corp., Cannon Electric Co., Telecomputing Corp., McCulloch Motors Corp., and many others.

JAMES L. COBURN
Dallas-Fort Worth section

Mr. Coburn is a quality control engineer with Convair, A Division of General Dynamics Corp., Fort Worth, Tex.

DR. H. C. HAMAKER
International section

Doctor Hamaker studied physics at Utrecht University from 1923 to 1929. He took part in an oceanographic expedition in the East Indian Archipelage, and then returned to Utrecht to acquire his doctorate in physics in 1934.

During the same year he joined the Philips Research Laboratories in Eindhoven, Netherlands, where he worked mainly on problems of electron emission until 1945.

He had become interested in modern statistics as a student, and after WW II he started to actively apply statistical methods in the Philips industries, where he now holds the position of Chief Statistician.

Doctor Hamaker was elected a member of the International Statistical Institute (ISI) in 1951, and was appointed secretary of its committee on statistics in industry and technology, of which he became chairman in 1958. In this capacity he has been largely responsible for the establishment of the *International Journal of Abstracts on Statistical Methods in Industry*, in which the ASQC has taken an active interest.

He is a member of the ASQC and the RSS, and has taken an active part in the operations of the Dutch Statistical Society and the European Organization for Quality Control.

Doctor Hamaker has written a number of papers on sampling inspection theory and practice and on the use of experimental designs in industry.

FRANK W. WEHRFRITZ
Metropolitan section

Mr. Wehrfritz is a graduate of Syracuse University with a B. S. in Chemical Engineering. He received a M. S. in Applied Statistics from Rutgers University.

He has been the membership chairman of the Metropolitan section, was a vice-chairman of the Ninth National convention, and was chairman of the 12th Metropolitan Princeton conference.

Mr. Wehrfritz has written several articles on statistics applied to petroleum and chemical processes and has been a speaker at several sections and clinics.

He is staff engineer in the technical department of the Bayway Refinery of Esso Standard Oil and is also an Adjunct Staff Instructor at Rutgers University. He is a member of the American Statistical Association and of Sigma Xi.

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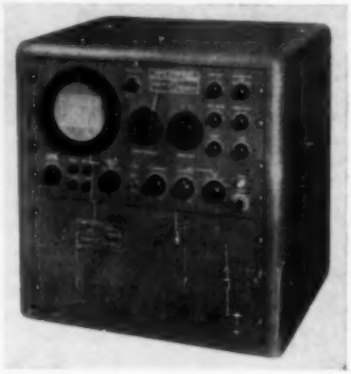

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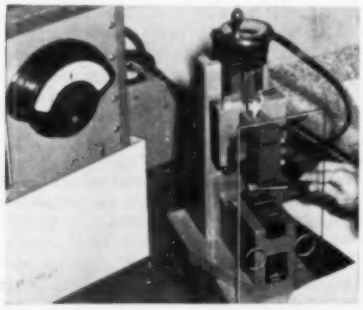
* * *



P-7-10—An Electronic Comparator, capable of detecting dimensional variations of one-millionth of an inch, has been announced by Federal Products Corp. The Model 130 B-12 was originally developed for measurement of Master and Working Gage Blocks in Federal's own Gage Laboratory. Because of its accuracy, ease of operation, and comparatively low cost, it was found that other gage laboratories were interested in securing the instrument for their own use. The Model 130 B-12 can accurately measure gage blocks as large as four inches. It's electronic amplifier provides four magnifications (2000:1, 6000:1, and 60,000:1) Graduations are 0.000030, 0.000010, 0.000003, and 0.000001 inches respectively. The precision-ground reference platen is fitted with two sets of three balls which provide an accurate three-point reference surface for comparing gage blocks. A reference surface of this type helps to maintain a constant temperature relationship between the Master and the workpiece. Parts are positioned quickly, and heat insulated tweezers can be used. The balls are spaced in one set to accommodate square blocks and the other set takes rectangular. Another type of anvil, one side serrated, the other plain and lapped flat, may be substituted for comparing parts other than gage blocks. The Electronic Gage Head is mounted in V-ways and is supported on a substantial base to eliminate danger of deflection. The gaging spindle is mounted on reed pantograph springs rather than in bushings to provide frictionless movement and to operate with very light gaging pressure so as not to mar highly polished surfaces. The gage head elevating screw provides easy coarse adjustment and is precision locked without shifting the indicating hand off-scale. Fine adjustment is accomplished electrically.

* * *

P-7-11—A new "spinner-type" sample holder makes it possible to measure the reflectance of colored samples of such fabrics as corduroy, gabardines, tricot knit fabrics and worsteds with directional weave, using "Color Eye", the optical colorimeter manufactured by Instrument Development Laboratories,

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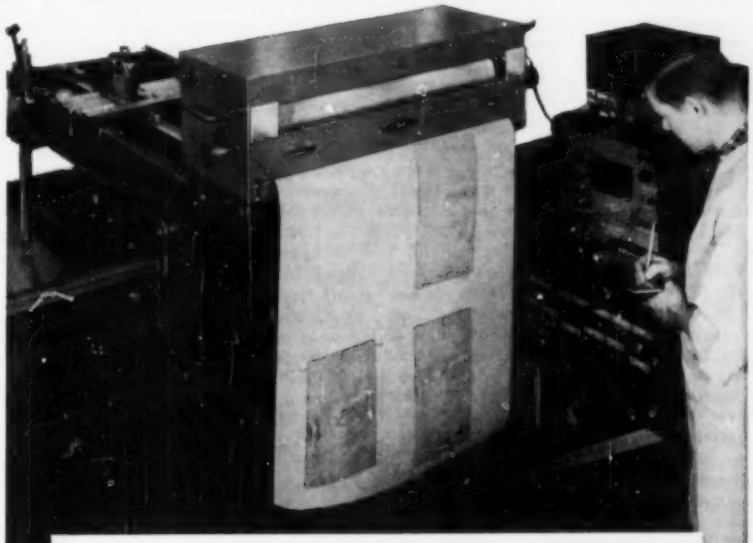
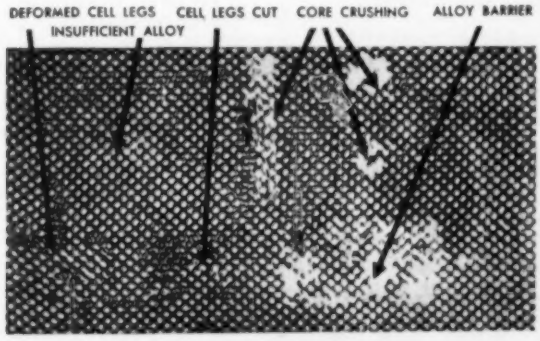


Curtiss-Wright is ultrasonically inspecting honeycomb with successful results. Our technique completely scans panels up to twelve feet wide, achieves high speed and provides an instantaneous permanent record.

Let us help you evaluate the application of this technique to your honeycomb quality control problem. Write, wire or phone for consultation with a Curtiss-Wright engineer today.



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Inc. It is also possible to measure the color of threads, yarns and synthetic fibres wound on cards. The new sample holder is a manually spun flywheel with concentric retaining rings for mounting samples. Other methods of mounting samples are also available. Until this special spinner-type sample holder was developed, it was generally impractical to completely evaluate or measure color on fabrics which display directional surface. The new sample holder enables the instrument to view an averaged and reasonably uniform reflectance surface. Interchangeable with standard sample holders, this new unit provides greater flexibility and a wider range of applications for "Color-Eye", the dual purpose colorimeter and abridged spectrophotometer.

* * *

P-7-13—CSI announces the addition of the NOPCO Ball Rebound Tester, Model CS-111 to its list of instruments. This unit was developed by Nopco Chemical Co., North Arlington, N. J. The apparatus consists of an 18 inch vertical, clear plastic tube, into which a 5/8 inch diameter steel ball is released by an electromagnet. Circles scribed on the tube aid in the visual recording of the rebound height. A single pole, single throw switch is used to connect the voltage source to the magnet. The ball-drop resilience test consists of dropping a 5/8 inch diameter steel ball from an 18 inch height on a flexible foam specimen, and measuring the rebound. This rebound, as a percent of the drop height, is the ball-drop resilience. The ball-drop resilience is influenced by different quantities than the compression (Instron) Resilience defined in LP-8P-A, "Load-Deflection Tests of Flexible Urethane Foam." Because of the comparatively high rate of loading in the ball-drop test, pneumatic damping due to air flow through the foam cells may be a significant factor. In addition, the polymeric creep may be quite different at higher loading rates.

* * *

P-7-15—An electrical device that gives continuous and automatic width measurements without machine interruptions, and which actuates an alarm if pre-set tolerances are exceeded, is now available to the textile, paper, and plastic film industries from Matrix Controls Company, Inc. The Margin Meter is a boon to mills, processors, and manufacturers, where present measurement techniques require frequent machine stopping. In paper plants, the Margin Meter is suitable for monitoring cross machine stretch. Insensitive to sideslip, this instrument consists of a measuring unit and an Indicator which gives an instantaneous width reading as the material passes. Plugged into a 115 volt ac outlet, the Margin Meter is ready to operate after setting an edge allowance dial and two tolerance pointers. Optional with this measuring system is a recorder that prints a continuous width record. In operation, the indicator can be placed at a distance convenient to the operator. As the material moves over the measuring unit, the Indicator shows the exact width continuously without stopping the machine. If the width should exceed either the high or low tolerance setting, the operator is alerted by a flashing red light or audible alarm. When the Recorder is used, the print-record can be attached to the roll for subsequent operations.

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Make your presentation more forceful and understandable by the use of these aids.

QUINCUNX
... This device permits your audience to visualize the creation of a normal distribution pattern as well as the results of variables sampling. All beads are self-contained; nothing to drop out. Done in attractive mahogony complete with zipper carrying case.

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... Complete unit consists of transparent plastic container, opaque colored beads, and wood paddles permitting easy identification of beads at a distance.

SIMULTATORS
... To demonstrate control chart plotting and shift of distribution pattern.

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St. Petersburg Beach 6, Fla.

New Literature Available

L-7-1—The Tubular and Split Rivet Council has announced publication of a new industrial guide on "Dimensional Standards for Semi-Tubular Rivets." Designed to facilitate the work of industrial rivet users, this new guide contains standards data on all major classes of semi-tubular rivets. It includes, for the first time in an easy-to read chart form, such information as body and head diameters, head thicknesses and radii, and hole diameter and depth figures.

♦ ♦ ♦

L-7-2—A new catalog of Precision Standards of Mass, Volume and Length has been issued by W. & L. E. Gurley. The 32-page illustrated bulletin describes the complete line of standard weights, standard linear measures, standards of volume and includes new comparative weight tolerance charts and weights and measures reference tables.

♦ ♦ ♦

L-7-3—A new 12 page brochure on black granite gaging products has been issued by the DoAll Company. The brochure includes a selector chart listing 432 combinations of plate sizes, ledges and over-all accuracies that simplifies the selection of a surface plate. Three different grades are offered: AA for laboratory work, A for inspection work and B for shop work. A separate listing of plates in accordance with Federal Specifications for size, thickness and accuracy is included in the brochure. In addition to surface plates, it includes plate stands and gaging accessories such as angle plates, straightedges, parallels, magnetic chuck platforms, master flats and deburring stones.

♦ ♦ ♦

L-7-4—Applications, features, operating characteristics, specifications and other details of portable moisture monitors made by the Analytical and Control Instrument Division of Consolidated Electrodynamics Corp. are described in an illustrated eight-page brochure. CEC offers two types of instruments for monitoring or control of moisture in gases or gaseous mixtures. Type 26-301 has a range from 1 to 1000 parts per million, while Type 26-302 operates in a range from 1 to 20,000 ppm.

♦ ♦ ♦

L-7-5—Three new accessory data sheets, describing a variable thickness liquid absorption cell, 7.5 cm. small volume gas cell and the evacuable potassium bromide die accessories for its infrared spectrophotometers, have been published by the Instrument Division of the Perkin-Elmer Corp.

♦ ♦ ♦

L-7-6—Bulletin E describing their new Pet-Line gages and measuring instruments, is now available from Petz-Emery, Inc. Described in the bulletin are two versatile comparators, a variety of depth gauges and weighted indicators, as well as the Jumbo Magnetic Base Indicator Support.

♦ ♦ ♦

L-7-7—A 20-page booklet entitled "The ABC's of RUST-LICK for Rust Prevention" is now available. It presents basic information on rust, its causes and application of preventives.

♦ ♦ ♦

As a result of the overwhelming success in response to the Transistor Workshop Lecture Series held by the Boston section of IRE in April and May 1959, the section has arranged to make available in one bound volume the six complete sets of lecture notes on the use and applications of transistors. The notes are available (at a price of $5.00 postpaid) from: Boston Section, The Institute of Radio Engineers, 73 Tremont Street, Boston, Mass.

♦ ♦ ♦

A booklet entitled "Polyvariable Experimentation" is available on request to F. E. Satterthwaite, 8 Fuller Road, Wellesley 81, Mass.

♦ ♦ ♦

L-6-6—Bulletin GEA-6829 describes new nationwide instrument rental program established by General Electric through its network of service shops. An eight-page bulletin discusses the scope of the program and other pertinent factors involving more than 13,000 instruments offered for rent.

section briefs

ALLENTOWN-BETHLEHEM . . . The annual reorganization of the Executive committee was held June 10 in the Game Room of the Hotel Traylor. Incumbent officers and committee chairmen turned over their books and records to the incoming officers. Speakers recalled events of the past year, such as the Fifth District Conference—of which we were the host section, and also the section's instruction courses.

Our new program chairman, Marty Wohlbruck, was able to announce our complete program for the coming year, thanks to the help of the outgoing program chairman Wes Sawyer and the outgoing section chairman Dave Hilder. Nine scheduled meetings include two local participation sessions, a plant tour, and three dinner meetings. The section plans to conduct clinics prior to the regular meetings as a stimulant to attendance. It looks like a banner year for our section!

BINGHAMTON . . . During the first executive meeting of the year, attention was directed primarily to the planning of the year's activities. Speakers for the year's programs were selected and plans outlined to continue the program of teaching quality control in night classes at the various high schools and colleges in the area.

Plans are also being formulated to increase the membership of the section.

Officers elected for the year are: chairman—Don Moses, vice chairman—Stan Rogge, secretary—Ivy Runyan, treasurer—Bob Klein, directors—Mike Drabo and Don Edwards, and counselor—Joe Jirauch.

BOSTON . . . A 140 dollar collection of QC books was presented to the Northeastern University Library early in June by H. S. Davis, Book Committee Chairman. Joint meetings of incoming and outgoing section members, "Excom" and "Educom," were held in the early weeks of June so that committee "know-how" could be passed along.

Plans for the coming year include the "Total Quality Control" theme for our meeting series, beginning with Dr. A. V. Feigenbaum as our first speaker Sept. 2. Plans call for continued help to our Merrimack Valley subsection to gain section status and also aid to the Wentworth Institute Subsection through Carl Nickerson. Vice president W. A. Donovan reports that most of the year's meetings are settled. The program will be announced during the last week in August.

CINCINNATI . . . The Fourth Annual Dinner Dance and Business Meeting sponsored jointly by the Cincinnati and Hamilton-Middletown sections was held June 6 at the Greenhills Country Club, Greenhills, Ohio. In attendance were 130 members and guests. The outgoing section chairmen, Don Brandt of the Cincinnati section and Bob Merrill of the Hamilton-Middletown section introduced 1958-59 officers and committeemen. Newly elected officers were installed during the brief business session.

The new officers for the Cincinnati section are: chairman—Raymond Hauck, vice chairman—William Eilrich, secretary—Robert Johnson, and treasurer—Edgar Edelmann. Don Brandt, Cincinnati section retiring chairman, was presented with a gift of luggage.

In addition to the installation of section officers, two Cincinnati section members newly elected to Society offices were introduced. Bill Barker will be the District Eight representative. Dave Birch was elected Executive Director of ASQC.

CLEVELAND . . . Plant tours and issuance of a year book are new features outlined by the 1959-60 Executive Committee during a preliminary planning meeting June 19.

Educational chairman H. M. Wadsworth, Western Reserve University, is planning both an elementary and an advanced course in practical statistics early this fall.

The speaker for the first meeting of the fall season will be Wm. Pabst, Jr., chief statistician of Buord, Navy Department. Mr. Pabst will discuss, "Mobilizing statistical quality control for the National economy."

COLUMBUS . . . During a dinner and business meeting June 13, at the Desert Inn officers and committee reports were presented and plans for an interesting and educational program for 1959-60 were discussed.

DALLAS-FORT WORTH . . . Members and guests who attended the section's annual June dinner meeting were the victims of an intriguing and hilarious hoax.

After introductions, recognitions, and presentations, the new chairman introduced the speaker as Dr. Franz von Heidelman, noted German Industrial Consultant.

Dr. von Heidelman began his talk with rather general insults directed at the United States quality control organizations as a whole and at the Dallas-Fort Worth section in particular. This gradually led to his praising Germany and the German people, and finally to praising Hitler and slandering the people and leaders of the Allied Nations, especially Winston Churchill and F. D. Roosevelt.

Just at the time when it seemed the audience would explode in violence, Dr. von Heidelman suddenly jerked off his beard to reveal Jack Herman, a professional actor.

Approximately ten seconds of stunned silence was followed by a hearty applause when the victims realized that it was all a joke. Said one of the guests, "If that man had talked another minute, I believe I would have been up there after him".

After a short intermission, a forty-minute film was shown of last year's "This is your professional life" program, honoring J. Y. McClure.

The section's first regular monthly meeting for 1959-60 will feature Kenneth W. Davidson, branch manager in quality assurance, Texas Instruments, Inc. He will talk on "Reliability in a semiconductor industry".

EVANSVILLE-OWENSBORO . . . The September meeting will consist in a dinner meeting Sept. 15 at the Westhaven Gun Club. Speaker for the evening will be W. P. Sime, supervisor of quality control engineering, Production Engine Department, General Electric Evendale Plant, Cincinnati, Ohio.

GREATER DETROIT . . . The section will hold its 14th Annual Forum—All Day Conference Sept. 12, 9 a.m., at the Michigan Union, University of Michigan, Ann Arbor, Mich.

A highlight of this year's Forum will be the address by Martin Brumbaugh on the history, growth and future of quality control.

Key executives from all phases of industry will present papers covering evolutionary operation, operations research, quality who and how, and the use of IBM in quality control problems. Speakers for the Conference include G. W. McElrath, C. C. Craig and J. M. Juran.

To keep pace with the growing interest in statistical QC techniques, the fundamental statistical course will be presented again this year as one of the Forum's added attractions. For additional information, contact John Coppola, Forum chairman, 5900 Trumbull, Detroit 2, Mich.

GREATER MUSKEGON . . . The program committee met June 26 at the Black Angus restaurant in Grand Haven and started formulating plans for the coming year. Those attending the meeting were: Program Chairman—Elwood E. Pres-

EOQC to hold Third International Conference

The European Organization for Quality Control will hold its Third International Conference Sept. 16-18 in Brussels. The main subject of the conference will be 'Simplified Methods." Some eight leading experts in the field of QC have been invited to prepare papers dealing with both the theoretical and operational aspects of this theme. The papers will be delivered with simultaneous translations in English, French and German.

Information regarding the program, registration and reservations may be obtained by writing to:

Dr. J. D. N. de Fremery, Secretary
European Organization for Quality Control
Weena 700
Rotterdam, Netherlands

ley, Eagle Ottawa Leather Co.; Albert Baker, Muskegon Piston Ring Co.; William Hume, Anaconda Wire and Cable Co.; Lester Shaw, Gardner-Denver, and Joseph Yerina, General Electric. In addition to the above program committee, Chairman Lawrence Long and Secretary William Poe were present.

HAMILTON . . . Diversified and interesting meetings were planned June 4, during a meeting of the executive committee.

A meeting of the "Annual Forum" committee was held and responsibilities delegated on June 18. The University of Western Ontario and the St. Catherine sections will cooperate in jointly sponsoring the event.

HAMILTON-MIDDLETOWN . . . The Annual June Dinner-Dance, sponsored jointly by the Cincinnati and Hamilton-Middletown sections, was held June 6, at the Greenhills Country Club. The evening consisted of cocktails, dinner and a short business meeting at which time Robert Merrill, outgoing chairman, introduced the Hamilton-Middletown section officers for 1959-60. The officers are: chairman—John Bemesderfer; vice chairman—DuWayne Carlson; secretary—Robert L. Harris, and treasurer—Joseph Mead. A dance followed the meeting, and a good time was had by all.

Coming events for the Sept. 9, meeting include a coffee talk by Patrolman Elmer Robisch on "Narcotics" after which John W. Gower, an attorney from Dayton, Ohio, will speak on the "Legal aspects of quality control."

HARRISBURG . . . The executive committee along with all other committees are working diligently to present a program for the coming year that will create new interests, not only within our section, but throughout the area. Our goal this year is to plan a program that will be on a level that the majority of members and guests will understand.

The membership committee has gone "all out" this year. The committee is divided into ten groups, each with a specific function, as follows: renewals, new members, new companies, attendance, welcoming visitors, inactive member follow-up, student members, committees, mailing lists, and membership contest.

INDIANAPOLIS . . . Our final meeting of the season was well attended, including 1945 Charter Members Virg Alexander, Art Bender, Dr. Irving W. Burr, Senator McDermott, and Keith Ross, as well as ASQC Director Tom Turner.

The new president spoke at length on the unique character of our Indianapolis membership, and promised that all the members will be served in the coming year. Regular monthly programs will be conducted in combination with other professional organizations whose members we want on the "QC Team" where we work.

September 14, 15 and 16 we will be host section to the 14th Midwest Quality Control Conference. With 21 technical sessions, both basic and advanced training courses, and a well planned Ladies Program with Miss Bonnie Small talking on "Quality control from a woman's viewpoint," you can bring your whole family and enjoy the wonderful recreational facilities of the French Lick Hotel.

KANSAS CITY . . . Section officers for the next year have been elected. Jay Rumberger succeeds himself as chairman, and the section is looking for continued growth under his capable leadership. Vice chairman is Cliff Cutler, secretary—D. M. Thomas, and treasurer—V. J. Smeltzer.

GEORGE H. SELIG

The Hartford section regrets to announce the death of George H. (Bob) Selig on June 23. Mr. Selig was born in Stratford on Dec. 16, 1917. He was a resident of Newington for the past 16 years and was sales manager for the Pratt & Whitney Co., Inc., West Hartford.

Bob was a founding member of the section and served on all major committees as well as being a past chairman. He had been Hartford's representative on the New England Conference committee. A senior member of the Society, Bob was serving as advisor to the chairman of the section's executive committee.

This section and many others will miss the genial warmth, untiring effort, and unceasing leadership displayed by Bob Selig over the past years.

LOS ANGELES—The featured speaker at the June meeting was Maj. Gen. Pearl M. Robey. His talk brought forth a record attendance of 467 members and guests.

LOS ANGELES . . . At the clinic session preceding the June meeting, a discussion on the QC developments the Chemical Division has to offer industry was led by Jesse Black of Shell Chemical.

The featured speaker on the main program was Maj. Gen. Pearl M. Robey, USAF, commander of the Ogden Air Material Area, Hill AFB, Utah. A record turnout of 467 came to hear the general speak on "Quality control of missile propellants." General Robey discussed QC of chemicals in solid-fuel ballistic missiles such as the new Air Force Minuteman.

General Robey has been closely associated with the manufacture of solid propellants, petroleum products and other chemicals for many years. While serving as chief of QC for the Air Material Command between 1948 and 1950 he was responsible for modernizing this Air Force function from mere inspection to the present field of QC.

His talk before the section was his last major speech as an active duty officer. General Robey retired from the Air Force in July.

The program for the coming year has been prepared under the guidance of Halmond Parks, section vice chairman, and the "kick-off" meeting is scheduled for Sept. 15. Due to the price increase for dinner at our former meeting location we have changed the site of our meetings to the Carolina Pines Restaurant which offers a more reasonable price. The move was made as one of the aims of the section's executive board in fulfilling the desires of the membership for better meetings, easier to reach locations, and more reasonably priced dinners.

MEXICO CITY . . . The section conducted a course on QC at the "Camara Nacional de la Industria" during the second and third weeks of June. Instructors were Ing. Enrique J. Gonzales L., senior member, and Ing. Domingo M. Lopez, fellow.

New officers are: chairman—Quim. Jorge Davalos Morales; vice chairman—Ing. Francois R. Le Ray; secretary—Ing. Domingo M. Lopez, and treasurer—Ing. Enrique Gonzales Lara.

MID-HUDSON . . . An executive meeting was held on June 11, at the Western Printing & Lithographing Co., Poughkeepsie, N.Y., to discuss the agenda for the coming season. Various committee heads were appointed, and a tentative program was agreed upon.

A general type of meeting will be held for the first meeting of the season 7 p.m., Sept. 8, in the Anchor Inn, Poughkeepsie, N.Y. There will be a general discussion of the various committee functions in ASQC. Representatives from local companies will be invited to the meeting to acquaint them with QC.

MILWAUKEE . . . The executive committee of the Milwaukee section met on June 24, at the Stratford Hotel. The following Committee Chairmen were appointed for the coming year: Program—Hy Pitt, Oscar Mayer & Co., Madison; education and training—John Melchior, Miller Brewing Co.; membership—Ray Wachniak, Pressed Steel Tank Co.; publicity—John Stephan, Froedtert Malt Corp.; arrangements—Patricia Mulgrew, Globe Union, Inc.; professionalism—Bill

Kohl, Allis Chalmers Mfg. Co., West Allis, and Seventh Industrial Clinic, Bill Donlevy, Froedert Malt Corp.

MONTREAL . . . "Tex" Coulter, former Army, U.S., and Canadian Pro football star, addressed members and their wives at the Annual Meeting and Dinner on June 3. Claude Taylor presented the Saddoris Award which he had accepted at Cleveland on behalf of the section.

The 1959-60 executive committee was elected. It is made up of chairman—D. W. Guthrie; vice chairman—Frank Clow; secretary-treasurer—J. L. Gauthier, and immediate past-chairman—C. I. Taylor.

Committee chairmen are G. Williams, program; D. Schroeder, membership; R. Lessard, education and training; S. Baburek, arrangements, H. Grigsby, publicity; C. I. Taylor, subsection development; J. Pringle, examining; G. Gould, audit, and R. V. Ward.

New directors are F. Clow, H. Grigsby and S. Baburek and D. Schoeder.

The opening meeting for 1959-60 will be a social evening at Molson's Brewery on Sept. 23.

NORTHEASTERN INDIANA . . . New officers for 1959-60 are: chairman—Ardith E. Carter, Dana Corp.; vice chairman—Ellis B. Cash, Office of the Inspector of Naval Material; secretary—Harry B. Richardson, General Electric Co., and treasurer—Howard F. Spicer, General Electric Co.

NORTHEAST TENNESSEE . . . Myles Duellman, delegate to the Cleveland Convention, met with representatives of sections of District 10 concerning mutual programming problems. Dr. Hubert Hill, section chairman, has appointed his committees for the next year. These committees are already forming plans for a busy year.

PHILADELPHIA . . . The "Fourth Annual Symposium on Quality Methods and Management" will be held this year at Mitten Hall, Temple University, Sept. 11.

The first part of the program will begin at 9 am and will conclude at 5 pm. Lunch will be served. Our guest speaker will be C. E. Fisher, President of ASQC. The lectures scheduled are varied and up to date and should prove to be of interest in all fields of quality control.

The second part, which commences at 6 pm, will be a dinner meeting. Our guest speaker, S. J. Lorber, chief of the inspection and QC division, Office of the Secretary of Defense, will speak on "Quality Assurance."

Aircraft and Missile Division News

The Aircraft and Missile Division held its annual meeting May 25 in Cleveland at the Sheraton-Cleveland Hotel. More than 40 members and guests attended the meeting which was conducted by vice chairman and chairman-elect, W. A. MacCrehan, Jr.

Annual reports by all officers and committee chairmen reflected a prosperous and eventful year. Division membership continued to grow and reached an all time high of 783, which is an increase of 28 percent over last year. This year also marked the first time that all districts were eligible for Council representation.

Certificates of Recognition

During the meeting, certificates of recognition were presented by the Division to nine individuals who had, during the year, contributed outstandingly to Division projects or to QC in general.

John J. Riordan, Department of Defense, was presented a certificate of recognition for his work on Department of Defense QC and reliability programs.

John T. Bailey, Bell Aircraft Corp., was recognized for his progressive work as chairman of the Aerospace Industries Association QC Committee. A similar certificate was given to David R. Archibald, Convair-Astronautics, for his work on the AIA guided missile QC committee.

Dayton Conference

The very successful Dayton Conference last November earned recognition for five Division members: Dr. Max Astrachan, Air Force Institute of Technology, Conference chairman; William E. Smith, National Cash Register Co., co-chairman; Robert C. Draudt, North American Aviation, Inc., and William F. Morgan, Sperry-Farragut Co., program chairmen, and John W. Gower, engineer-attorney, publicity chairman.

George B. Westerhaus, Beech Aircraft Corp., was presented a certificate in recognition of his work as editor of the Division's Newsletter.

Election of Officers

The Tellers Committee announced the election of officers for the coming year. They are: chairman—W. A. MacCrehan, Jr., Bendix Radio; vice chairman—David R. Archibald, Convair-Astronautics; secretary—J. W. Griswold, Boeing Airplane Co.; and treasurer—John G. Rutherford, Lear, Inc.

Councillors were elected for each of the districts. These were reported by the Tellers Committee to be:

District	Councillor
1.	C. V. Kropp
2.	V. R. Grom
3.	W. A. Gurnack
4.	P. F. Merchant
5.	H. D. Greiner
6.	E. F. Taylor
8.	J. C. McKay
9.	L. C. Whitcomb
10.	Karl V. Holm
11.	J. I. Krebes
12.	V. G. Hildyard
13.	G. B. Westerhaus
14.	R. P. Bosche
15.	G. F. Lamkin
16.	F. W. McNabb

This fine group of new officers and councillors will continue to work for the betterment of the Division and its service to the membership. The retiring officers and councillors wish the best of success to the new officers and councillors and wish to thank all members and other participants in the activities of the past year.

Meet your new Division officers: (left to right) W. A. MacCrehan, Jr., chairman; David R. Archibald, vice chairman; and John G. Rutherford, treasurer. Secretary J. W. Griswold is not shown.

SECTION CALENDAR (AUGUST 25—SEPTEMBER 31)

SECTION	DATE	PLACE	TIME	SUBJECT	SPEAKER
Allentown-Bethlehem	Aug. 29	Heffner's Barn, Trexlertown	4:00 pm	Annual Family Outing	———
Boston	Sept. 9	Hotel Traylor, Allentown	6:30	100 Percent Inspection—Its Strength, Weakness, and What to Do About It	Dorian Shainin, Rath & Strong, Inc.
	Sept. 2	M.I.T. Faculty Club Penthouse	6:00	The Total Quality Control Concept	Dr. A. V. Feigenbaum, General Electric Co.
Cincinnati	Sept. 16	Engineering Society Bldg.	8:00	SQC Can Be Made More Effective	Thomas A. Budne, QC Consultant
Cleveland	Aug. 28	Mamolin's	8:00	Executive Committee	———
	Sept. 4	Cleveland Engr. Society	8:00	Mobilizing SQC for the National Economy	Wm. R. Pabst, Jr., U. S. Navy Dept.
Dallas-Fort Worth	Sept. 24	Sky-Chef Room, Amon Carter Airport	8:00	Reliability in a Semi-conductor Industry	K. W. Davidson, Texas Instruments, Inc.
Evansville-Owensboro	Sept. 15	Westhaven Gun Club	6:30	Quality Costs	W. P. Sime, General Electric Co.
Greater Detroit	Sept. 12	University of Michigan	9:00 am	14th Annual Forum	———
Greater Muskegon	Sept. 11	Bill Stern's Steak House	6:30 pm	———	———
Hamilton	Sept. 17	Westinghouse Auditorium, West End plant	8:00	———	J. Manuel, Westinghouse Electric Corp.
Hamilton-Middletown	Sept. 9	Hamilton	6:30	Legal Aspects of Quality Control	John W. Gower, Attorney
Hartford	Sept. 1	Nutmegger House	5:30	Executive Committee	———
Indianapolis	Sept. 14	French Lick Hotel	7:30	French Lick in '59, Hawaii in '60	National Officers
Los Angeles	Sept. 15	Carolina Pines Restaurant	6:00	Solar Battery—Space Implements	L. G. Hector, Sonotone Corp.
Mid-Hudson	Sept. 8	Anchor Inn, Poughkeepsie	7:00	ASQC	Panel Discussion
Montreal	Sept. 23	Molson's Brewery	8:00	Social Evening	———
Syracuse	Sept. 22	Syracuse Turners	7:00	The Supervisor—Key Man in the QC Program	J. Fred Verigan, Olin-Mathieson Corp.
Toronto	Sept. 9	University of Toronto	8:00	Basic Principles of SQC	S. P. Zobel, University of Buffalo
	Sept. 23	———	———	Plant Tour	———
Univ. of W. Ontario	Sept. 23	Kitchener	8:00	Production—QC Relations	Panel Discussion
Utica	Sept. 15	Hotel Hamilton	5:00	Who Controls Quality—and How?	Warren R. Purcell, Raytheon Co.

G. Nimick of the Gulf Oil Corp. is directing and coordinating the entire symposium. Reservations for the dinner meeting should be directed to Miss Mary Wolcott, Phone SA 7-1500. Guests are Welcome.

PHOENIX . . . The June dinner meeting included wives and guests of the members. Following the dinner, Harold Olsen, president of PHEMCO Mfg. Co., spoke on "Management takes a look at quality control."

Following his talk officers for the 1959-60 fiscal year were installed. The outgoing chairman, J. G. Sorauf, was presented with an engraved gavel. The section has planned a vacation period for July and August and will resume the monthly meetings in September.

PIEDMONT . . . The section has recessed for the summer. The annual business meeting was combined with an informal discussion, and a delicious dinner was enjoyed by a relatively large turnout at Tryon, N.C.

The section has elected the following officers for the coming year: chairman—Carlos Gallimore; vice chairman—H Elliott Foster; secretary—Clifton H. Smith; treasurer—William P. Stover. We would like to welcome our new officers and thank our present ones for a fruitful year.

Bill Stover has completed teaching a weekly course in basic QC at Asheville, N. C. We hope others will follow. Our next series of monthly meetings will begin in September, "where the summer spends the winter"—Tryon, N. C.

PITTSFIELD . . . More than 40 members, wives and guests attended the most successful outing in the section's history at the Oak N' Spruce in Lee, Mass. The afternoon and evening of June 25, was reserved for the section. Swimming, golf, archery and similar activities were available. A barbecued chicken dinner was served and was followed by dancing. Entertainment was provided by Doty Slingerland, wife of our section chairman, Doug, who performed several humorous pantomime numbers.

ROCHESTER . . . The fourth and latest sub-group to be formed by the section will be known as the reliability subgroup. The chairmanship of the sub-group has been accepted by Earl F. Peacox, Stromberg Carlson Division of General Dynamics Corp. Under his able direction we are certain that the infant group will grow very rapidly.

SAN ANTONIO . . . More than 115 members and guests attended our installation of officers ceremonies and annual picnic on June 16. This event was held in the "German Beer Garden" of the Lone Star Brewery, with the program starting at 6:30 p.m.

Installation of officers ceremonies was first on the agenda. This was followed by a delicious Barbecue Chicken dinner with all the trimmings. The successful event closed with a two-hour dancing session under Texas skies to the music of Don Laurner and his Combo.

Three lovely door prizes were awarded to lucky winners at the midway point of the program. This event officially closed our FY 1958-59 season. The section is anxiously awaiting the beginning of the next season Sept. 22. It will feature Ken Davidson of Texas Instruments as the guest speaker.

SAN DIEGO . . . "San Diego Industrial Coordinator Appointed," "Nation's Greatest Resort City to Become Industrial Center," "Mayor Appoints Industrial Development Commission"—newspaper, radio and television announcements such as these are quite common in our San Diego and these days an undercurrent of progressive force is evident in all aspects of our community life as the once sleepy little resort town moves to take a position of importance in the industrial world.

To date 15 major industrial areas have been established in San Diego and surrounding towns. Manufacturing operations range from light industry and warehousing to heavy industrial activity in both commercial and military categories.

The impact of this rapid industrial expansion on our San Diego section will be tremendous. Progressive thinking combined with dynamic leadership during the coming year will

Bay Area QC Conference

The Sixth Annual Bay Area Quality Control Conference will be presented at Stanford University, Thursday, Sept. 17, under the sponsorship of the department of industrial engineering of the University and the Bay Area section of ASQC.

The conference program will feature double sessions; one designed to initiate newcomers into the field, and the other for experienced workers wanting more advanced technology.

Carnegie Tech Offers Courses

During the coming academic year Carnegie Institute of Technology will offer, in its evening program, two-semester credit courses in Experimental Design, Probability and Mathematical Statistics, and Quality Control and Industrial Statistics. The courses will meet one evening per week, Monday, Wednesday, and Friday evenings respectively, 7:30-10:30 pm, Sept. 1959 through May 1960. Registration for the courses will be Sept. 15, 16 from 6:30-9:30 p.m. For further information regarding graduate and undergraduate day courses, write to Professor Edwin G. Olds, Department of Mathematics, Carnegie Institute of Technology, Pittsburgh 13, Pa.

have a profound effect on the position quality control will assume in this addition of major industry to the land of the "Fiesta and Siesta" Adios, Amigos.

SYRACUSE . . . Fifteen students were graduated from our basic and nine from our advanced 1958-59 courses.

The basic course in quality control which was started in Watertown in April will continue this September after a summer vacation. Robert Peiffer is the instructor.

Two courses will be taught again this year in Syracuse, beginning in September. These will consist in a beginning course for people who have had little or no training in quality control, and a second course designed for people who have had some training in the subject. Watch your newspapers for detailed announcements, and encourage interested people to attend. Registration fees are nominal.

TENNESSEE . . . All section members wish to congratulate Dave Chambers, our most active member, on his election as Executive Secretary of ASQC.

Several committee appointments have been made for the coming year. Pete Littleton is chairman of the Program committee. Alan Lasater is Saddoris Award chairman and IQC reporter, and Roberta McCutchen is chairman of the membership committee.

TORONTO . . . Preparations for the 1960 QC Forum are off to an excellent start. The Forum committee has already been established and we are pleased to announce that James A. Jenning, QC statistician of the Canada Wire and Cable Co., has agreed to function as committee chairman.

TULSA . . . Buford M. Appleman, service manager, Texas Foundries, Lufkin, Tex., spoke on scrap reduction programs June 15 at the Michaelis Cafeteria.

The Tulsa section now has a job placement service, with Jim Justice of the Navy Inspection office as chairman. Companies or individuals looking for jobs or replacements are urged to contact Mr. Justice, phone LU 4-7161.

A membership contest has been initiated, effective the first of June. Any member sponsoring four new members during the coming year will receive a silver lapel ASQC membership pin.

We will need many new members this year to help us achieve our goals for good QC in this area.

Your outgoing chairman wishes to thank the many members who have contributed so much to our first year as a section of ASQC. We feel that we have a very fine section in Tulsa, and with over a hundred members signed up in our first year, we should be able to build our section into one of the leading societies in Tulsa. Thanks again, one and all.

UNIVERSITY OF WESTERN ONTARIO . . . The executive committee has been meeting regularly to prepare the program for the fall season. The first meeting will be held Sept. 23, in Kitchener. It promises to be an interesting one. The relationship between production and quality control will be discussed by an able panel. The Kitchener-Waterloo Foremen's Club will be invited as guests at this meeting.

UTICA . . . New nominating chairmen were instructed in their tasks during the meeting of the executive committee June 23 at chairman Ray Morton's house. Geno Albergine presented the program for the coming year. From all indications, it will be the best in the section's history.

Mr. Morton described the way in which we will win the Saddoris Award (or at least rank higher than the Syracuse section).

YOUNGSTOWN . . . The first meeting directed towards the 1959-60 season was called June 3, by our new section Chairman Paul Belter. Duties and responsibilities were discussed for the benefit of the new officers. Retiring officers briefly explained their activities during the past season and suggested methods for improving the efficiency of the section during the coming season.

A tentative list of members who are qualified for positions as committee chairmen was prepared. Committee chairmen are to be selected sometime prior to the August executive meeting. In addition to the chairman the following members were present: Bob Jones, Bill Cain, Ron White, Bill McHenry and Fred Eboch.

SIGNIFICANT DIFFERENCES

. . . Allentown-Bethlehem—The most significant differences at the moment are those created by the election of section officers. In the 1959-60 season our section will be in the very capable hands of chairman—**Ken Stephens**, Western Electric Co.; vice chairman—**Paul Connolly**, Dixie Cup; secretary—**Dick Zwickl**, Parish Pressed Steel, and treasurer—**Dan Scrobe**, Western Electric Co.

. . . Boston—**William A. Donovan** has recently been promoted to senior QC engineer of the Footwear and Flooring Div., B. F. Goodrich Co., Watertown, Mass.

Benjamin Marguglio has accepted a position at the Middle River Plant of the Glenn L. Martin Co., Baltimore, Md.

Clarence H. Tenny, Jr., is now QC supervisor of the American Can Company Bradley Sun Div., Haynard, Mass.

Ralph F. Tibbitts is a section head of the reliability engineering group at Sanders Associates in Nashua, N. H.

Irvan J. Bearer is now supervisor of QC systems and procedures, Missile Systems Div., Raytheon, Lowell, Mass.

. . . Buffalo—**George V. Vosseller** has been appointed plant manager with Nilock Chemicals, Inc., Lockport, N.Y.

. . . Cincinnati—**Bill Eilrich**, section secretary, received his MBA degree at Xavier University commencement exercises June 9. Mr. Eilrich is employed as a QC engineering supervisor by General Electric.

Dr. Bob Lollar, formerly of the section, has accepted employment with the Armour Research Foundation, Chicago. **Ray Hauck**, formerly of the University of Cincinnati Research Laboratory, has also accepted a position with Armour Research Foundation, Chicago, as a research scientist. Mr. Hauck will continue work toward his doctorate. Both Bob and Ray will be missed as they were both very active, participating members. Ray, elected chairman for 1959-60, has resigned the chairmanship to accept his new position.

J. L. Abels, manager of quality for General Electric, is on temporary assignment as a project manager for General Electric's rocket engine section.

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If you can qualify and are interested in the position, please send a resume of your background and experience to:

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Director of Technical Personnel
Collins Radio Company
Cedar Rapids, Iowa

POSITION OPEN: Quality Control Manager
COMPANY: Bloomer Bros. Company
LOCATION: Newark, New York State
NUMBER OF EMPLOYEES: 550
SALARY: $8,000 - $9,000

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The Quality Control Manager should either be a chemical engineer or well grounded in chemistry with specific quality control training and some years of experience.

He will be responsible for the organization and management of the Quality Control Section whose duties will be to inspect and evaluate quality of raw and finished material and the investigation of the source and the cause of substandard material and waste. He will manage seventeen people including Testing, Printing Quality and Outgoing Quality Supervisors.

Newark is a pleasant village of about 10,000 halfway between Rochester and Syracuse with excellent educational and recreational facilities either present or closely available.

PROCEDURE: Written applications should include full educational, business and personal histories. Address to Karl W. Schantz, Production Control Manager.

. . . Cleveland—**W. C. Lyman** has been transferred by B. F. Goodrich from Cleveland to its headquarters at Akron, Ohio. Fortunately Mr. Lyman will be able to continue his work as vice chairman of the program and speakers committee.

. . . Dallas-Fort Worth—The executive committee voted to move the location of our regular meetings to the Sky-Chef Room at Amon-Carter Airport beginning with the meeting in September.

Our congratulations to section director **Jack D. Brown** who was recently promoted to vice president of sales for Morton Foods.

. . . Greater Muskegon—Section vice chairman **Elwood Presley**, Eagle Ottawa Leather Co., Grand Haven, was recently elected to serve two years on the council of the American Leather Chemists Association. The announcement was made June 16 during the Association's convention at the Grand Hotel, Mackinac Island.

. . . Hamilton-Middletown—**Robert L. Harris** is on leave of absence from the controls development unit and has been assigned the task of developing and programming for the Ohio Div. Champion Paper & Fibre Co.

. . . Harrisburg—**James T. Skelton**, superintendent of inspection and statistical QC, Caterpillar Tractor Co., York, has been re-elected as a Director of ASQC.

H. A. Gross, RCA, Lancaster, has been appointed Dist. 5 representative for the coming year.

. . . Hartford—Section chairman **Herbert A. France, Jr.** has been appointed manager of QC for Pratt & Whitney Co., Inc., West Hartford.

. . . Indianapolis—The Adair Award has been given to Charter Member and Past President **Dr. Irving W. Burr** for continuous service to the section. We wish to congratulate Dr. Burr for being awarded the Shewhart Medal during the same year.

New section officers for 1959-60 are: president—**Mel Handerson**, Western Electric; vice president—**Bob McNeff**, Diamond Chain; secretary—**Rog Heimlich**, Cummins Engine, and treasurer—**George Blackburn, Jr.**, Eli Lilly.

. . . Kansas City—The section welcomes a new member, **George M. Cohan**, Fellow, ASQC, who has recently accepted a position as head, statistical QC section, for Bendix Aviation Corp., Kansas City Div. Mr. Cohan was formerly with the USAF Inspection Agency at Salt Lake Cty, Utah.

Cliff Cutler, section vice chairman and senior member, ASQC, has recently been promoted to QC department supervisor at Hallmark Cards, Inc.

. . . Los Angeles—**Howard C. Todt, Jr.**, past section chairman, has been promoted to a new position as manager, procurement QC of Autonetics Div., North American Aviation.

Jack Lancaster, Ballistics Missile Center and the new section membership chairman, almost singlehandedly saw to it that the June meeting had a good turnout for General Robey. Through his persistent efforts, 467 attended, a record for Los Angeles. We wonder if this is not also a society record for a single section dinner meeting.

John M. Howell and **Benjamin K. Gold**, both of Los Angeles City College, are continuing to assist the Society educationally as participating instructors with Edward P. Coleman, UCLA, at the annual UCLA quality control courses in August.

Fred P. Myers recently joined Aerojet General as a project QC engineer. Fred was formerly statistical quality engineer on the Corporal Missile at the Firestone Tire and Rubber Company's Guided Missile Div.

. . . Metropolitan—**Barbara Fox** has been appointed an associate member of the technical staff of Bell Telephone Laboratories, Inc., in its Electro-Mechanical Development Department at Whippany, N. J.

. . . Montreal—**Garry Gould**, formerly of Canadair, Ltd., Montreal, is now with H. & D. Machinery Co., Toronto, Ont.

. . . Phoenix—**D. Dan Kasky**, chairman for the Western Regional QC Conference to be held in Phoenix Oct. 23-24, indicates that plans for the conference are well along. The speakers' list for the conference has been completed as well as all arrangements for conference rooms. Publicity is being drafted presently and will be mailed within the next few weeks.

. . . Richmond—**N. L. Enrick** has been promoted associate director of research by the Institute of Textile Technology, Charlottesville, Va. Mr. Enrick has been head of the statistics section at the Institute since 1956.

. . . San Antonio—**Wm. T. Smith** recently attended a three week course in Advanced Quality Analysis sponsored by the Air Force Institute of Technology in cooperation with the Ohio State University, at AMC, Dayton, Ohio.

. . . Tennessee—**Alan Lasater** was married to Katherine Mounger of Knoxville on June 27. Their address will be 610 W. Vanderbilt Drive, Oak Ridge.

clinics, conferences, and courses

SEPTEMBER

. . . **1-2**—Conference on Physical Chemistry in Aerodynamic and Space Flight. University of Pennsylvania, Philadelphia, sponsored by the Air Force Office of Scientific Research and the General Electric Company's Missile and Space Vehicle Department, 3198 Chestnut Street, Philadelphia 4, Pa.

. . . **9-16**—Applied Statistics and Quality Control, Rutgers • The State University, New Brunswick, N. J., contact either Prof. Ellis R. Ott or Prof. Mason E. Wescott at Rutgers.

. . . **11**—Fourth Annual Symposium on Quality Methods and Management," Mitten Hall, Temple University, Philadelphia, co-sponsored by Temple University and the Philadelphia section of ASQC, contact Dr. Russell Mark, Temple University, 1817 North Broad St., Philadelphia 22, Pa.

. . . **12—Fourteenth Annual Forum, University of Michigan, Ann Arbor, sponsored by Greater Detroit section of ASQC, contact John Coppola (Forum Chairman), Detroit Controls Corp., 5900 Trumbull, Detroit 2, Mich.**

. . . **15-16**—Registration for evening courses in Experimental Design, Probability and Mathematical Statistics, and QC and Industrial Statistics, Carnegie Institute of Technology, Pittsburgh, contact Prof. Edwin G. Olds, Department of Mathematics, Carnegie Institute of Technology, Pittsburgh 13, Pa.

. . . **16-18**—Third International Conference, Brussels, Belgium, sponsored by the European Organization for Quality Control, contact Dr. J. D. N. de Fremery, secretary, European Organization for Quality Control, Weena 700, Rotterdam, Netherlands.

. . . **17—Sixth Annual Bay Area QC Conference, Stanford University, Stanford, Calif., sponsored by Stanford University and the San Francisco Bay Area section of ASQC, contact R. J. Berkhimer, 1468 Olympus Ave., Berkeley 8, Calif.**

. . . **20-25**—14th Annual Conference and Exhibit of the Instrument Society of America, Chicago, Ill., sponsored by ISA, contact ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

. . . **24-25—Third Annual Technical Conference, Shamrock Hilton Hotel, Houston, Tex., sponsored by the Chemical Division, ASQC, contact K. K. Keneaster, publicity chairman, Chemical Division Training Conference, Uncle Ben's, Inc., P.O. Box 1725, Houston 1, Tex.**

OCTOBER

. . . **13-14**—National Training Conference, "Progress in Plastics Engineering," the Ambassador Hotel, Los Angeles, Calif., sponsored by the Southern California Section of the Society of Plastics Engineers, contact Thomas A. Bissell, Executive Secretary, Society of Plastics Engineers, Inc., 65 Prospect Street, Stamford, Conn.

. . . **19-30—Reliability Training Course for Middle Management, Atlantic City, N. J., sponsored by the Professional Group on Reliability and Quality Control and the Electronics Division of ASQC, contact H. N. Hadley, 45 Martin St., South Acton, Mass.**

. . . **22-23**—SQC Conference, Milan, Italy, sponsored by Italian Association for Quality Control, contact Segreteria del Convegno sul CSQ, Associazione Italiana per il Controllo della Qualita—Sezione di Milano, Piazza A. Diaz, 2, Milano, Italy.

. . . **23-24—1959 Western Regional QC Conference, Phoenix, Ariz., sponsored by ASQC (host section—Phoenix).**

NOVEMBER

. . . **2-5**—11th Exposition of ARI, Atlantic City, N. J., sponsored by Air-Conditioning and Refrigeration Industry, 1346 Connecticut Ave., N.W., Washington 6, D. C.

BOOK REVIEWS

W. D. Baten, Editor

26 University Drive, East Lansing, Mich.

NUMERICALLY CONTROLLED MACHINE TOOLS—IMPLICATIONS FOR MANAGEMENT, by H. Clifton Morse and David M. Cox (Walter R. Catey, Technical Editor), Cox & Cox, Chicago, 1958. Reviewed by Harmon S. Bayer, Quality Control Consultant.

Numerically controlled machine tools are standard general purpose machine tools with electronic controls connecting them to computing devices with feedback arrangements. In this way, many operations are accomplished without any operator involved and programmed with electronic tapes.

The authors feel that these automation devices and principles portend a second industrial revolution which will have tremendous impact on industrial competitive positions and even on the basic makeup of the industrial organization.

The authors endeavor to create a sense of urgency in the reader that this revolution is here and a company that doesn't prepare for the upheaval and develop applications and subsequently wholesale changeover may lose in its competitive position.

The authors also endeavor to indicate the impact on each of the present industrial organizational components. It is interesting to note that the authors attempt to debunk what they call is the myth of loss of jobs and subsequent blow to labor by this technique.

If one accepts the premise and pursues it, the professional quality control reader may have some suggestions for the authors. It is apparent they have some appreciation for the quality control technique. They do point out that quality control organizations must learn to apply SQC techniques and use capability studies to prove out the ability of the process. However, they fail to note one important factor that is being exposed by those quality control people who have had experience with automation. These people find that the major role that quality control can play is to prevent the setting of automatic feedback and sensing devices to limits narrower than the capability of the machine or process. If this is not done, the adjustment devices constantly hunt producing worse variation than when the limits are set to account for machine capability.

The book (or report) could have been drastically edited and condensed. Its constant repetition of ideas try the reader's patience. It is also questionable whether the pages of procedural examples are necessary to the text.

About the best comment a reviewer can make is already present in the comments requested by the authors from industrialists and included without editing in the book whether sympathetic or not.

"It seems to us that tape controlled machine tool equipment is not quite the 'revolution' that some people try to make of it. . . . Each technological forward step has some advantages (usually greater productivity or accuracy) and disadvantages (usually greater initial costs). . . .

" . . . we view numerical control as just another technological forward step which will have its labor pains, its prophets and its debunkers, and will find a limited area of usefulness."

The authors feel they are prophets of what they choose to call a second industrial revolution.

AN INTRODUCTION TO STOCHASTIC PROCESS WITH SPECIAL REFERENCE TO METHODS AND APPLICATIONS, by M. S. Bartlett, Cambridge University Press, Cambridge, 1956, Price $6.50, pages xiv—312. Reviewed by Dr. Irving W. Burr, Purdue University.

Stochastic processes include any processes or operations involving some randomness. Thus a series of random events or a time-varying quantity are stochastic

processes. The subject in its full generality is highly abstract and mathematical. The author's aim is not pure theory, but is to present a wide variety of methods and examples from many subject-matter fields. He has succeeded well in this. Nevertheless the reader will need considerable mathematical background to read the book profitably. He should have a sound background in advanced calculus, matrix algebra and some mathematical statistics, while knowledge of measure theory would be helpful. The more advanced and abstract analysis and algebra is not necessary, however, as the author makes use of the same kind of approach one finds in many theoretical engineering books. There are many quite concrete problems with data.

The scope of the book is shown in the following chapter headings: introduction, random sequences, processes in continuous time, miscellaneous statistical applications, limiting stochastic operations, stationary processes, prediction and communication theory, the statistical analysis of stochastic processes, correlation analysis of time series. Anyone reading the book thoroughly will not only have the subject well in hand, but will also be able to apply it.

Italian Association Plans Conference

The Italian Association for Quality Control will sponsor a statistical quality control conference in Milan, Italy, Oct. 22—23. Sessions will be held at the Chamber of Commerce, via Meravigli 11, Milano. Foreign participants are invited to attend free of charge.

The conference will be opened at 9:30 a.m. with papers by the official speakers on the theoretical and practical aspects of statistical quality control. Additional papers will be presented at 2:30 p.m., followed by a discussion. The discussion will be continued at 9:30 a.m., Oct. 23, with visits to local industries at 2:30 p.m.

For additional information, contact Associazione Italiana per il Controllo della Qualita, Secretariat of the SQC Meeting, Piazza Diaz 2, Milano. Telephone—892 285. Telegram—AICQ, Piazza Diaz 2, Milano.

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John Schimmel III
Sprague Electric Company
North Adams, Mass.

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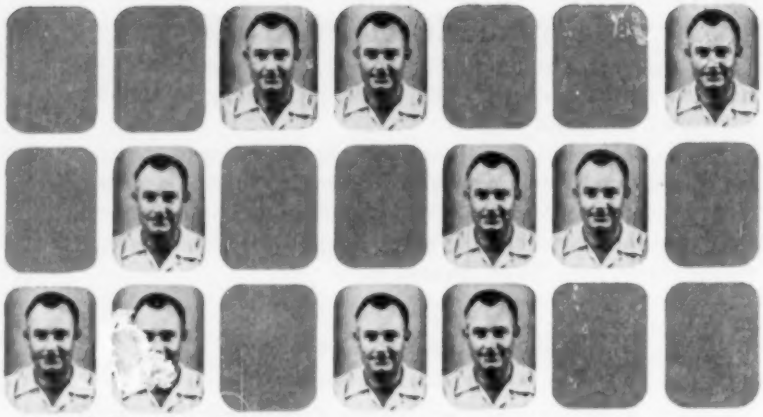

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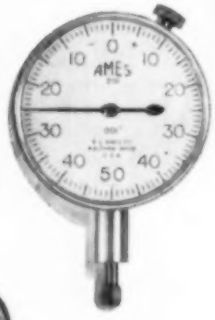

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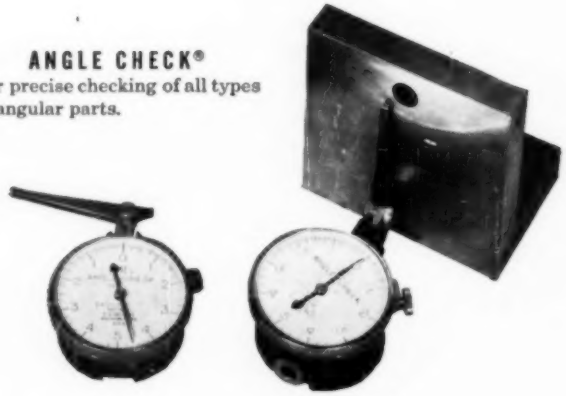
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